MATERIALS SCIENCE & Engineering

125 YEARS

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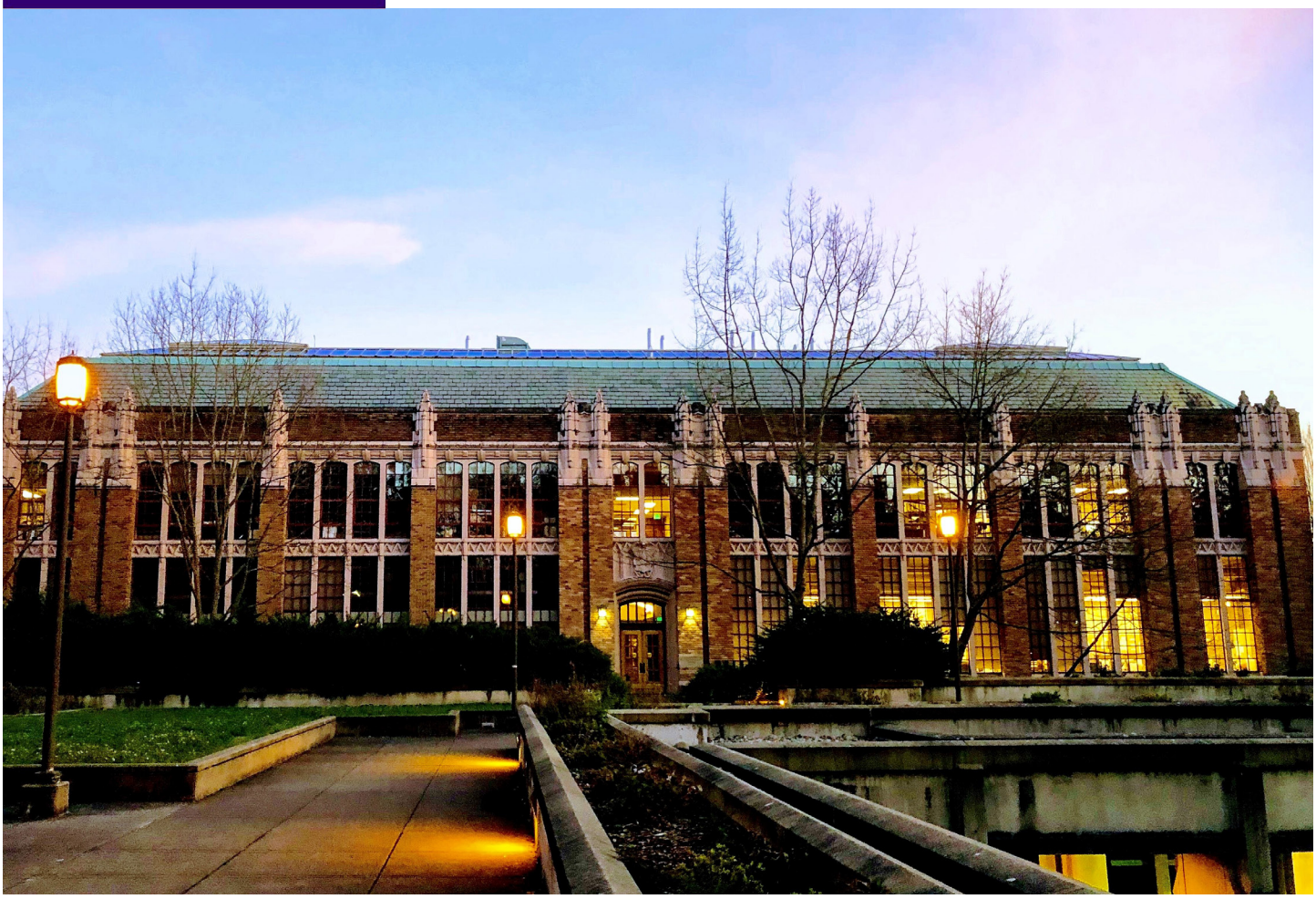
MSE Quasquicentennial

The Evolution of Materials Science and Engineering at the University of Washington

1894 - 2019



Part 1: Centennial History

(1994)

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(2019)

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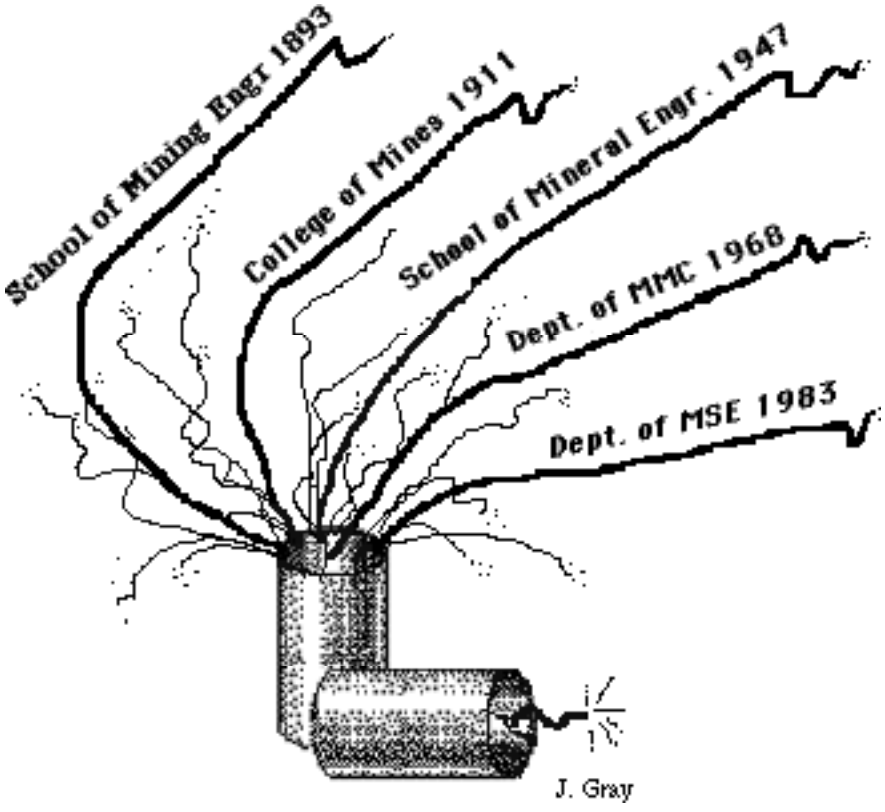
Centennial !!

From Mining, Minerals, Metals and Ceramics to

Materials Science and Engineering,

A Century of Progress at the University of Washington



Department of Materials Science and Engineering

University of Washington

1994

PREFACE

I first learned of this history project in 1987 when Art Kramer, an Electrical Engineering alum, interviewed me on the subject. The College of Engineering's History Committee had set out to write a history of the College. Mining was the first engineering discipline taught at the University of Washington, and granted the first engineering degree. Since our Department is the direct descendent of the College of Mines, we were to be the first department in the history.

I soon learned that the School of Mining Engineering was chartered in the fall of 1893 by the Board of Regents, and its curriculum developed in 1894. Although there was the complicating factor that the initial mining program was an adjunct of the Geology Department and the School was not fully implemented as an independent entity until 1901, it was clearly the first functioning engineering program at the University, granting its first degree in 1900. (Civil Engineering, the oldest of the other Engineering programs, granted its first degree in 1901.)

Later, when the College of Engineering decided to celebrate its centennial, it chose as its beginning year 1893-1894, when the first engineering program was authorized and developed in Mining Engineering. Since this is the centennial of the College of Mines, and by inheritance, the centennial of the Department of Materials Science and Engineering, we pushed forward with this account to ensure our rightful place in history! Eventually, it will be one chapter in the history of the College of Engineering, but for our alumni and friends, as well as our staff, this one chapter is us, past, present and future.

Mr. Kramer, who passed away in 1992, is to be credited with the initial research and the original draft of this history. Carolyn Stoebe, my daughter-in-law, has done subsequent research and editing while Professor Myron White of the Technical Communications Department provided a full final editing of the manuscript. Input was also received from a myriad of former students and faculty; of these I shall mention only Professors Donald Anderson, O.J. Whittemore, Alan Miller and Douglas Polonis because of their tireless reviews of the manuscript. However, I gratefully acknowledge all other inputs that I have received, especially that from our alumni, with thanks.

Photographs that are reproduced in the book are principally from the University or the Department Archives. The firecracker logo on the cover was designed by Jennifer Gray.

In this centennial year of the Department, we are providing our alumni and friends the opportunity to get together again to revisit old times and to reflect on new ones.

Thank you all for participating, for reading this history, and for understanding the importance of the growth of our Department from the College of Mines; the School of Mineral Engineering; and the Department of Mining, Metallurgical and Ceramic Engineering to the Department of Materials Science and Engineering. We appreciate sharing with you the recognition of our Department and its importance in the development of engineering at the University of Washington, as well as the equally important roles its programs have played in the development of technology in our state and nation.

Thomas G. Stoebe

Department Chairman

March 1994

INTRODUCTION

The history of the Department of Materials Science and Engineering at the University of Washington has its beginnings in the mining industry and the minerals that prospectors discovered in Washington State toward the end of the Nineteenth Century. Prospectors found the state to be relatively rich in minerals and began establishing mines near Everett, Lake Chelan, Newcastle (Issaquah), Monte Cristo, Bellingham, Chehalis and Republic, as well as other locations throughout the state. These mines produced gold, silver, copper, lead, mercury and coal, and some are still producing, for example, the Knob Hill Gold Mine at Republic, and Chehelis Coal. The search for minerals brought many people to Washington, of course, but it was the need to understand and process these materials that brought students to the University.

Although the Department began in the allure of mining, over time the academic emphasis shifted to the study of metallurgy, ceramics, and such newer materials as composites and electronic materials. As a result, the emphasis of the Department also broadened to include not only practical training but also basic and applied research involving a wide variety of materials. Areas of research now, 100 years later, include fundamental studies of the structure and properties of materials, corrosion and erosion, high-temperature behavior, biomaterials, fracture mechanics, lattice-defect-related properties, materials processing and sintering, and the preparation and properties of semiconductors--areas never dreamed of by our founders! Today's search for new materials parallels the miner's search for minerals but it uses both natural and artificial sources to find the combinations of materials needed for today's technological challenges.

THE BEGINNING YEARS

Perhaps the first important name in the beginning of the Department's history is that of the Reverend George F. Whitworth. Having lived in eastern mining regions and having firsthand knowledge of the mining business, the Reverend Whitworth came to Seattle in 1866 looking for coal. Upon his arrival, he was appointed the third president of the University of Washington. Within a year, he had also organized the Lake Washington Coal Company, which developed coal mines in Issaquah and Renton. Although Whitworth served as the University's president for only two years, his influence led to a state law that required the University to purchase local coal for its steam plant, a practice that continued until 1969.

How much influence the Reverend Whitworth had on the event remains unknown, but on November 28, 1893, the Board of Regents established the School of Mining Engineering "to educate men for the industry." The proposed curriculum of the School was developed in 1894 and published in the University Catalog of that year, but the School itself did not materialize for several years. Instruction in mining and assaying began in 1895, taught by Professor Henry Landes, a geologist who also taught mineralogy. Initial instruction took place in the new, but not-quite-completed Administration Building (now Denny Hall), with classes held on the first floor and laboratory work conducted in "The Assay Shop," a temporary structure located 100 yards north of Denny Hall. Over the next three years, Professor Landes' teaching commitments increased to a broad range of geology courses and, early in 1898 he requested a laboratory assistant. The regents turned down the request, but one of them volunteered to give a course of lectures. Regent Lincoln D. Godshall, Ph.D., the volunteer, lectured on *Metallurgy, Assaying and Analytical Chemistry*.

Administration Building (now Denny Hall) 1895

Assay Shop, circa 1895

Professor Landes was the force at the University who pushed for the full implementation of the plans for a School of Mining Engineering. His teaching of assaying and the subsequent establishment of commercial assaying shops helped make Seattle an important hub in the development of the Yukon and Alaska gold fields as well as the development of many of the mines in Washingto n State. His efforts to encourage the Board of Regents to fulfill

their intention of establishing a full-fledged School of Mining Engineering bore fruit in 1898. Thereafter, Landes' career continued at the University until 1936; during his career, he was State Geologist (1901-1921), Dean of the College of Science (1910-1932), and even Acting University President (1914-1915).

Henry Landes

In the summer of 1898, Landes finally prevailed and a permanent Instructor in Geology and Mining was appointed. He was Dorsey A. Lyon, who had just received his A.B. degree from Stanford University. Mr. Lyon developed considerable versatility at the University. Over the next three years, he became Assistant Professor of Geology and Physical Geography in the School of Pedagogy (now the College of Education), and Assistant Professor of Mining Engineering in the School of Mining Engineering; on the general roster of faculty, he was Assistant Professor of Mining Engineering and Instructor in Chemistry.

Dorsey Lyon

The same year that Professor Lyon came to the University to develop the Mining Engineering Program, Professor Almon H. Fuller came to take charge of the Civil Engineering Program. The following year, 1899, Professor Fuller was named Dean of the College of Engineering, which was developing in parallel with, but independent of, Mining Engineering.

There are some inconsistencies and contradictions in the University records concerning the organization of programs in the period 1889-1901. Before 1889, both Engineering and Mining Engineering are listed in the University Catalog, but with no faculty; during this period, the names "School of Mining Engineering" and "College of Mines and Mining" seemed to be used interchangeably. The University Catalog for 1898-99 lists Mining Engineering as part of the College of Engineering, even though the courses were joint with Geology. For 1899-1900, the School of Mines is again listed independent of the College of Engineering, but Professor Fuller is listed as Dean of both, while for 1900-1901, Prof. Lyon is listed as Dean of the School of Mines. However, other sources, including Milnor Roberts' History of the College of Mines, indicate that these appointments as Dean were not actually realized. According to Roberts, Professor Lyon was not offered the job as Dean until 1901 but resigned from the University before this title was official. Milnor Roberts was then hired as the first Dean of the School of Mines.

During the academic year 1899-1900, Assistant Professor Lyon, with the help of invited guest lecturers, developed additional courses in mining and metallurgy; he also had the assistance of Professor Landes, who continued to teach some mining courses. Thus, by this time, the Mining Engineering Program had a full-time qualified instructor and provided a curriculum leading to a degree. Courses required for the bachelor's degree included mineral formation, mining surveys, mine development, mining machinery, assaying, ore testing, smelting and refining.

The School of Mining Engineering granted its first degree in 1900. The first five students to receive degrees in Mining Engineering were:

Ernest W. Schroder	1900
Alton Wayland Lane	1901
Walter H. Tiedaman	1901
Climie Eugene Hill	1902
Lewis David Ryan	1902

In Geology at the University of Washington, 1895-1973, Professor Julian Barksdale notes the important ties between Mining and Geology during the early years. Even the administration of the Program was the same as that for Geology until 1901. Professor Barksdale also notes the importance of the Mining Program, especially its instruction and services in assaying. Barksdale writes:

By 1899, Professor Lyon was particularly in demand for his services as an assayer for the public. This led to the institution of charges for assaying:

Qualitative analysis	$2 to $5
Quantitative analysis for each element determined	$2
Complete analysis	$5 to $25

This decision by the University brought two reactions: glee from the commercial assayers and resentment from the prospectors who always thought of the University as a public service institution. This fee policy was continued by Dean Roberts.

In fact, such charges continue today based on a state law that prohibits the University from charging less for services than local commercial suppliers.

The importance of the Mining curriculum and the impact of Professor Lyon on the University can be measured in terms of the success of the Program, which translated economically into Professor Lyon's salary: In 1899 when Lyon was promoted to Assistant Professor, he made $1,000 for the year. Early in 1901, he was promoted to full professor at a salary of $1,500 (Landes, the second highest paid professor at the University made $1,800). At the same time, the success of the Mining Engineering Program under Professor Lyon (with a student body of 39 in 1899-1900 and 41 in 1900-1901) led to plans for the full implementation of the School of Mining Engineering in the 1901-1902 academic year.

In the 1890s, the mineral industry in the state was second only to that of lumbering and miners, like lumberjacks, stood out as rough and ready men. Even so, the University professors easily built understanding and rapport with them, for the professors, like the miners, were robust, spirited, and practical men. In 1899, Professor Lyon invited mining men to attend a three-month "Winter Mining Session," which was the first of its kind in the U.S. It filled an evident need, for it continued for the next 27 years and became well known to other western mining colleges, where similar courses were introduced. Later, Dean Roberts wrote in his 1936 *History of the College of Mines*:

> "The pioneer course at the University was more technical and had a larger enrollment than any others; one of the sessions was attended by fifty-five. Alaskans were among the most interested attendants."

Both students and faculty enjoyed fraternizing with the miners, and the latter often invited the students to tour their mines; such invitations were accepted enthusiastically.

DECADE OF 1900-1910

Dean Milnor Roberts was appointed to head the now-official School of Mining Engineering in 1901. This led to program expansion, including broadened curricula, interactions with high schools, and increased student populations. This decade marked the full establishment of the School as a major part of the University's educational program.

Faculty

Milnor Roberts

Despite his promotion to full Professor and his increase in salary, Professor Lyon left the University in 1901 to pursue further studies in metallurgy at Harvard University. The Regents authorized a search for his replacement, leading to the appointment of Milnor Roberts, who had been educated in Hartford, Connecticut, at Cutler Academy in Colorado Springs, and at Stanford University, where he earned his B.A. in 1899 and carried out graduate studies in Mining and Geology, 1899-1901.

By 1901, in accordance with plans Professor Lyons had developed, the School of Mining Engineering was fully established to handle the Mining Engineering Program. Mr. Roberts was appointed as the Dean of the School as well as Professor of Mining and Metallurgical Engineering. With the cooperation of Professor Landes and the continued help of special lecturers, Dean Roberts propelled the School to a leadership position on campus. A personable, fun-loving professor and campus leader he remained Dean in the developing University for 46 years.

For his School, Dean Roberts designed equipment to be used in four successive laboratories for mining and metallurgy. He also gave time to many campus activities. In 1902, he became a member of the Athletic Committee and served, for 15 years, as its Chairman. During this time, several coaches he had engaged developed championship teams. Before leaving this assignment, Roberts introduced the system of a single student manager and a central student fund to support athletics.

Dean Roberts frequently served as an officer in local and national engineering societies and wrote many technical papers. In these professional relationships, Roberts showed quite a talent for charming professionals into donating money to the School of Mining Engineering.

Other faculty in the School during this decade included Harry Levi Mead, from Columbia University, who was added to the roster in 1905 as Instructor in Mining and Geology both in the School of Mining Engineering and the College of Liberal Arts.

In 1906, Raymond Bugby was appointed Assistant Professor of Mining, but he did not return the next year. His replacement was Clarence Raymond Corey, who became Instructor in Mining and Metallurgy. In his metallurgy classes, Corey introduced the (newly discovered) mysteries of cell structures in metals to hundreds of students, with the use of a metalloscope (an early day metallurgical microscope), enabling them to see the shape and size of grains which make up the microstructure of the metal.

Clarence Corey

Curriculum

If a student whose interest was primarily mining wished to shun the cultural preparation required in the College of Liberal Arts, he was welcome in Dean Roberts' School of Mining Engineering. The degree was B.S. in Mining and Geology. In this program, languages, philosophy, history, and all but four credits in English were replaced by surveying, mining, assaying and metallurgy courses. Also required were mineralogy, geology, paleontology, petrography, and economics.

The enrollment in the School more than doubled in this decade: in 1900-1901, there were 41 students; in 1909-1910, the enrollment was 85.

In order to teach practicality as well as theory, the University maintained its connections with working professionals. Students toured mines for "hands on" experience. Quoting from Roberts:

> "On the day after Christmas, 1904, a party of students accompanied by Dean A. H. Fuller (Dean of Engineering) and the writer (Milnor Roberts), numbering 25 in all, made a ten day excursion to the Sunset Copper Mine, six miles by trail above Index. The party included Miss Mayme Lucas, the first co-ed miner, better known as 'Texas,' and her father, a mining man with interests in Alaska.
>
> After establishing themselves in the bunkhouses and treading out trails in the deep snow, the students repaired the power flume, started the Pelton wheel and compressor, blew the whistle, and began drilling practice. The mine was surveyed and sampled and geology studied."

The Washington Tyee of 1905 devoted four pages to this trip made by the mining students.

As at engineering and mining colleges across the nation, Washington's School of Mining Engineering considered the assay laboratory to be the first step in developing a mining curriculum. It was at the assay lab that students evaluated and analyzed ore. In order to do this a student had to have a grasp of chemistry, be able to use weights and measures, understand the nature of precious and ferrous metals, and use keen perception.

In 1906, an innovative project of the School of Mining Engineering was the preparation of mineral displays for each of the 40 accredited state high schools. Each display included 70 typical ores, coals, clays, and useful rocks from the state. A 48-page descriptive pamphlet accompanied each set. Like gems, the ores were both eye-catching and educational.

The graduates of this decade contributed considerably to the development of mining and mineral extraction throughout the west. Livingston Wernecke, one example, was an assistant in Mining during his undergraduate years. Wernecke later became famous in Juneau gold mining, and found jobs for over 15 of Washington's graduates in Mining Engineering at the Treadwell complex of gold mines; later Wernecke was a consulting geologist for the famous Alaska Juneau mine. Wernecke is one of the early graduates who remembered his educational development with endowed scholarships in mining.

Facilities

When Mr. Roberts became Dean of the School in 1901, the semi-circular room at the southwest end of Denny Hall served as the Dean's Office and instruction continued in the assay shop. However, these quarters were cramped due to the growth of the University. By 1902 the School moved out of Denny Hall and into larger quarters in the new Science Building (now Parrington Hall) which had recently been completed with a new powerhouse.

Science Hall, ca 1905

More changes followed. In 1905, a new foundry and ore-dressing lab were erected despite the Washington State Legislature's refusal to appropriate money for it. "The Mill", as it was called, was built under Dean Roberts, using local money. It covered an area 40 x 110 feet and was a complete ore dressing plant. The plant was located near the old powerhouse, had three decks and included breakers, a stamp mill, and full sized concentrator tables.

One year later, in 1906, the Board of Regents offered part of the campus to a promotional fair called the Alaska-Yukon-Pacific Exposition. In preparation for the exposition, which took place in 1909, one of the casualties was "The Mill". This loss was partially made up during the exposition by the working model of the Cripple Creek Gold Mine in Colorado, a display which later went to the world's fair in Belgium, then was housed in Roberts Hall, and finally was donated to the Museum of History and Industry in Seattle. After the Alaska-Yukon-Pacific Exposition of 1909 closed, the brick power house, located near the site of the current Suzzallo Library, was remodeled into offices, classrooms, and laboratory space for mining, metallurgy, ore dressing, and coal washing. This building, renamed Mines Hall, served as the headquarters of the School until the 1920's.

Mines Hall, 1910-1924

Mines Hall

Mines Hall lab

Special Programs

Local leaders and executives with mining expertise were of great help to the faculty. In 1900, Fred Rice Rowell, an attorney, gave a series of lectures on mining law. In 1906, B. N. Bennetts, a metallurgist from the Tacoma Smelter, lectured on tin and copper smelting; and George James, a businessman in Seattle, gave lectures on eastern coal mining. In 1908, Harvey L. Glenn of the United States Assay Office of Seattle was appointed Lecturer on bullion assaying, and Roger Taylor, Superintendent of the Tacoma Smelter, lectured on copper smelting. Dean Roberts returned the favor to the mining community the next year when in January, February, and March he offered special courses for miners called "Prospector's Geology and Mineralogy."

As the decade came to a close, the School of Mining Engineering too had concluded an epoch. It became a solid center for mining instruction, with established innovative programs; it acquired good classroom, office and laboratory space; and its enrollment was increasing. A pride in the School, good leadership, and enthusiasm carried it into the next decade.

THE DECADE OF 1910-1920

This decade marked the development of new curricula in metallurgy, ceramics, and coal mining, the change in name of the School to the College of Mines, and an increase in faculty from two to four members. World War I,

which the U.S. entered in 1917 had an effect on the College, since the U.S. government took control of most segments of the country's production, including all coal and mineral mines. The Northwest Mine Rescue Training Station and the Northwest Experiment Station of the U.S. Bureau of Mines were established on campus and enhanced the College's programs for several decades to come.

Faculty


Joseph Daniels

In 1911, Joseph Daniels was appointed Assistant Professor in Mining and Metallurgy. Professor Daniels took charge of courses in coal, iron, steel, and allied subjects and was responsible for many of the new courses in coal mining engineering. Daniels is credited with many publications, especially on coal resources. Even after retirement he continued to work as a consultant in the United States and abroad. In 1911 C. H. Shamel became Lecturer on mining law and George Bates Harrington, Lecturer on the economics of mining.


Hewit Wilson

In 1918, Ira A. Williams from the Oregon Bureau of Mines was appointed as an Instructor to set up a new curriculum for Ceramic Engineering. After doing so, he left the University and Professor Hewitt Wilson replaced him. Mr. Wilson was a graduate of Ohio State University, where he also worked for two years as Assistant Professor of Ceramic Engineering. In addition, he had four years of plant experience. A man with novel ideas and wit, Professor Wilson proved to be an excellent teacher, researcher, and administrator.

Many University professors, having a desire to serve the wartime effort, found a variety of ways to contribute. This was the case in the College of Mines where Dean Roberts acted as a consultant in locating deposits of manganese, chrome, mercury, and tungsten in the northwestern states. Professor Corey trained with a faculty volunteer unit and Professor Daniels served as technical advisor to the State Fuel Administration as well as Chairman of the Military Survey Board.

Local leaders and executives continued to serve as lecturers and advisers during this decade. Frederick Powell, an engineer with experience in Alaska and the western states, was appointed lecturer on gold dredging. James Bagley, a state coal inspector, lectured on mine regulations and Dr. Guy M. Kerr, a graduate of Goettingen and metallurgist at the Tacoma Smelter, lectured on copper smelting.

Three new instructors contributed to the Winter Mining Sessions during this decade: Livingston Wernecke, Otto D. Rohlfs, and John L. McAllen. Then, under a joint agreement with the U.S. Bureau of Mines, the Northwest Mine Rescue Training Station was established at the University.


Mining demonstration circa 1920

The establishment of the Bureau of Mines' Northwest Experiment Station on campus brought with it a fine staff of mining men. These personnel contributed to the programs of the college through guest lectures and in directing student research projects.

With a mind to increasing the University's responsiveness to the people of the state, President Henry Suzzallo set up a series of advisory boards. Accordingly, in April, 1917, on recommendation of the Mines staff, he appointed the following men of the mineral industry as consultants to the College of Mines and liaison people for Dr. Suzzallo:

Roy H. Clarke	mining engineer	Spokane
John Erikson	mining operator	Seattle
J. T. Heffernon	mining operator	Seattle
E. C. Hughes	attorney	Seattle
Charles E. Jones	coal mine operator	Seattle
Charles Hussey	mining operator	Spokane
W. R. Rust	mining operator	Tacoma

Curriculum

This decade saw the addition of three new degree programs and a change in the name of the School. In 1911, the first new degree program was added, the B.S. in metallurgy. With the establishment of the separate metallurgy curriculum, an administrative reorganization took place, upgrading the School of Mining Engineering to a full-fledged College of Mines. Dean Milnor Roberts continued as Dean of this new College, which existed independently within the University for 33 of the next 36 years.

Later in the decade, a $40,000 purchase of electrometallurgical equipment was made, then installed in Mines Hall, in support of the Metallurgy Program.

Prof. Daniel's work related to coal mining led to the development of a degree program in this specialty in 1912, a program that remained intact for the next twenty years. This degree program was important in the establishment of the Bureau of Mines' Northwest Experiment Station.

In 1918, with the purchase of new equipment, a degree in ceramics could be offered. For the next 29 years, the University of Washington would be the only school on the Pacific Coast to offer a course in ceramic engineering. Interest in ceramics went back as far as 1901, when common bricks were burned from local clays. This product was followed by the manufacture of face brick, drain tile, and sewer pipe. While examining hundreds of mineral specimens from the state, the University found many to have industrial value. The Ceramic Engineering curriculum, aimed at training students to use these minerals for practical uses, was in place for the 1918-1919 term.

Each student in the College of Mines was required to present a senior thesis related to research or design applied to the specific degree program. This requirement had begun in the 1900s in the Mining Program and is still in effect today.

On April 2, 1917, America joined World War I and campus life began to change. The University went on an emergency basis to assist in the war effort. On the University grounds were navy and army barracks. The quarter system replaced the semester program to allow year-round studies. Many of the older students enlisted, while others found work in shipyards and wartime industries, and the faculty made contributions by serving as consultants to war-related industries.

During the war there had been a slight drop in enrollment of the College of Mines; after the war, it rebounded quickly, reaching an unexpected 121 for the 1919-1920 term.

Special Programs

The presence of the College of Mines at the University enabled it to attract federally funded programs to Seattle, including the Northwest Mine Rescue Training Station and the Northwest Experiment Station, both of the U.S. Bureau of Mines. The U.S. Assay Office was also established during this decade. All of these programs had direct dealings with University faculty and students.

Northwest Mine Rescue Training Station

The first-aid-to-the-injured movement had its origin in the coal mines of Pennsylvania and was carried out by different companies. When the U.S. Bureau of Mines was formed, it took up the work and divided it into three classes: First Aid to the Injured, Rescue Work, and Prevention of Accidents.

Mine Rescue Training Station, ca 1915

Mine Rescue Team, ca 1915

To bring the training in these areas to all mining regions, the Bureau equipped three railway coaches as mine rescue classrooms, placed them in the charge of competent men, and sent them to different mining districts across the country. The first of these coaches to arrive in the State of Washington came in the fall of 1910. Demonstrations were given in each mining town. Then, in 1911, a Mine Rescue Station was established at the University in the former Philippine Building of the Alaska-Yukon-Pacific Exposition. All trainees were qualified to receive a certificate from the American Red Cross Society. As soon as the station was opened on campus, all students of the College of Mines were required to take its instruction in first aid and mine rescue. Moreover, D. C. Botting, the state's Coal Mine Inspector, became a lecturer on coal mining regulations. This instruction continued into the 1930s, and a strong effort was made to have the miners of the state "100 percent trained."

Northwest Experiment Station

In 1916, every large city and mining institution in the four northwestern states offered inducements to the Bureau of Mines to be selected as the site for one of the Bureau's Experiment Stations. After visiting competing sites, a committee reported its recommendations to the Secretary of Interior, Dr. Franklyn Lane, and on November 21, 1916, he designated the University campus as the site of one of ten stations that Congress had authorized. The Station was set up in the Exposition's former Women's building facing Bagley Hall, and this highly prized acquisition eventually became a major center for research. Said Van H. Manning, its first Director:

> "Here it will serve the needs of the largest possible portion of the industry in the northwest, the facilities for cooperation are the best, and the Station can be reached in person by the greatest number of people in need of help in the solution of their mining and metallurgical problems."

The station opened with a staff of 13 people.

In 1918, the Northwest Experiment Station and the University jointly designed an electric furnace laboratory for experiments. Included in the laboratory were several furnaces in semi-commercial and commercial sizes. Cooperative studies in the next few years produced notable success in preparing sponge iron and synthetic cast iron, the making and testing of super-refractories, and the washing of coal.

Another experiment was conducted on the use of pulverized coal. During World War I, conservation of fuel had become a concern for the Puget Sound Power and Light Company. Then, after months of experimentation, the company began using powdered coal at its Western Avenue Steam Heat Plant, which supplied heat for buildings in downtown Seattle. The plant was able to use some 175,000 tons of coal mine sludge which had accumulated at the old Renton Mine. Now, this sludge was turned from a liability to an asset and was burned from 1919 to 1925.

U.S. Assay Office

The U.S. Assay Office in Seattle, established before 1910, received gold bullion from throughout the Northwest and Alaska until its closure in the 1950s. It was the site of a popular field trip where students could enter the vaults and gaze in awe at the stacks of gold bricks. Its presence allowed the transfer of assay services from the University to the new assay office.

At the Close of the Decade

This decade was marked by increased stature of the College of Mines, broadened curricula and increased student interest. Mining was at its peak; the year 1917 marked an all-time high in Washington State's coal production. Metallurgy and Ceramic Engineering were rapidly developing as important fields for the state and nation. The base established during this decade led to national recognition of the College and its educational contributions in the following years.

THE DECADE OF 1920-1930

Known as the Roaring Twenties, this decade is remembered as a boom or bust era and a dizzying time of change. At the University, the College of Mines, too, experienced sharp ups and downs.

Academically, the enrollment in the College of Mines continued to grow slowly. The faculty consisted of four men, Roberts, Corey, Daniels and Wilson, with the continued assistance of the local community. The first degree in

Ceramic Engineering, a master's degree, was conferred in 1921. In 1924, the 27th and last Annual Winter Mining Session was held in January, February, and March; a new Annual Mining Institute was established in 1928.

To relieve the shortage of classrooms, in 1919 construction of the first half of a new Mines Laboratory began. The College suffered a devastating fire in 1924 which destroyed the old Mines Hall; space was at a premium until 1927 when the second half of the Mines Laboratory was completed.

Curriculum

In the twenties, with 3 degree programs in place, students could choose from among a wide variety of courses in mining, metallurgy and ceramics, including the processing and properties of these materials. Considerable knowledge was being developed on the effects of heat treatments on steels, for example, and courses were available which introduced these new concepts. Mechanical testing and microstructural analysis were also introduced into the curriculum during this period. Other courses available included hydraulics, petrography, mining law and pyrometry.

Enrollment in the twenties languished, decreasing to 18 in 1927 before picking up again. The College's second female student enrolled in 1925, graduating in 1928.

In the twenties, the Department of General Engineering was established in the College of Engineering to teach freshman engineering courses. This department was organized under the direction of E. Roscoe Wilcox, a 1915 graduate of Metallurgical Engineering who remained chairman of that department for many years (Wilcox Hall is now named in his honor). The students in the College of Mines made use of these courses to introduce drawing, problem solving and applied mathematics.

Facilities

The first half of the new Mines Laboratory (the south half of the current Roberts Hall) was completed in 1921. Funds were appropriated by the State Legislature for this purpose as a result of the efforts of mining men throughout the state, President Henry Suzzallo, and Regent Winlock Miller.

New Mines Laboratory, circa 1921

This new building had four floors to be used as offices, classrooms, and laboratories for coal and ceramic engineering. In the rear of the main building was a two-story storehouse. Both buildings were faced with rug-textured brick made by the Far West Clay Plant in Pierce County and trimmed with terra cotta from the plant in Auburn. This new structure helped meet the needs of a student body now growing with returning veterans from World War I.

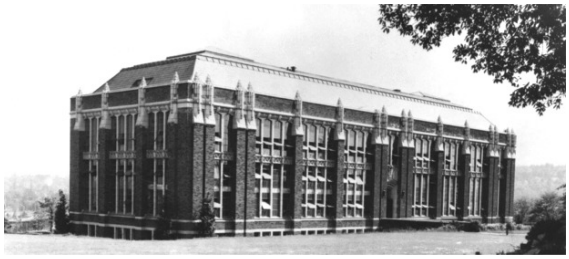
On December 16, 1924, the college suffered a serious loss. Passersby discovered the old Mines Hall in flames. The fire had originated in the steam tunnel under the building. When it reached the metallurgy stockroom it caused a great flare of brilliant colors. Hundreds of startled people quickly gathered on lawns in the University District, North Broadway, and the east slope of Queen Anne Hill, to watch the fire. Firemen were able to save only walls and the front portion of the building.

Some of the building's most valuable contents were lost. Maps, drawings and sets of ores that had been gathered on expeditions or given as gifts were destroyed. Also destroyed was Dean Robert's collection gathered during a quarter century of mining work. Among ores lost were invaluable ones from camps of the past such as Cripple Creek, Goldfield, and Alaska Treadwell. Students had rushed books to safety and some heavy machinery remained usable, but little else was saved. Other colleges of mines and mining companies responded to the loss with gifts of maps and ores.

The fire was a great blow to the College of Mines in several other respects. No building was available for temporary occupancy. The only course left was to double up in the new Mines Laboratory until it could be expanded. Entering students saw the crowded facilities and enrollment fell off. Although students suffered cramped quarters in the Mines Laboratory, work for the Northwest Experiment Station continued in a building near Bagley Hall.

Work began to enlarge the Mines Laboratory building, and in June, 1927 the building was dedicated with a special address by T. A. Rickard, mining editor and author. The second half of the Laboratory was designed to supplement the first half for permanent use. For some years, it would house the offices and library of the College of Mines, and provide classrooms, offices, and laboratories for the three departments of mining, metallurgy, and

ceramic engineering. Now, too, the offices and laboratory of the Northwest Experiment Station moved into this building. The building and equipment represented an expenditure of more than one-third of a million dollars.



Expanded Mines Laboratory, 1927

Mines Classroom

Mines Classroom

For the next two years, the Department of Civil Engineering also had the use of three drafting rooms and several offices. Two rooms with skylights were used by the Art Department for sculpture and metal work. In order to utilize the Ceramic Engineering equipment, courses in pottery, given by the Department of Painting, Sculpture, and Design, were also brought to the Mines Laboratory.

The building was the first of the Gothic-type on lower campus. The handsome new structure, equipped with the latest machinery and apparatus, attracted wide interest. Completion of the second half of the Mines Laboratory was encouraging, and the College of Mines again grew in enrollment and in stature.

Although there had been much suffering both in operations and enrollment because of the fire, the completion of the Mines Laboratory led to positive results and found men in the mineral industries increasingly seeking help from the College.

Development of National Recognition

When Hewitt Wilson had been appointed Assistant Professor in Ceramic Engineering in 1919, there was a special attraction to his field. Wilson was instrumental in organizing the Pacific Northwest Clay Workers Association, which later became the Pacific Northwest Section of the American Ceramic Society. Then, after four years of experimental work, Wilson wrote a paper, *The Clays and Shales of Washington*, published in 1923. Other papers followed, and in 1927, he wrote a book entitled *Ceramics: Clay Technology*. Ten years after the publishing of this book, Professor Wilson received an honorary degree of Doctor of Science from the Montana School of Mines. This degree was in recognition of his contribution toward the study of Montana's clays.

The College gained recognition through other published articles, as well. One, written by Dean Roberts during the latter part of this decade, was about the College of Mines. At the request of the American Mining Congress, Roberts prepared a detailed description of the College of Mines which was published in its July, 1929 journal titled Mining in the Northwest. Another was in relation to the region and opportunities available to graduates. Roberts had written another report which appeared in the Arizona Mining Journal, July 15, 1930, emphasizing these advantages. As a result of this publicity and word-of-mouth recognition from graduates, the College of Mines was nationally recognized not only as having the most strategic location of any in America for availability of mines, metallurgical works, and ceramic plants, but also as a place of great opportunities for graduates.

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Mining Institute, 1929

As part of the continuing program to marry the practicality of profession with academia, an Annual Mining Institute was established in 1928. This institute began in the third week of January and was to meet the constant demand for information and instruction by men in the mineral industry. There were morning and afternoon sessions and one or two evening addresses. Registration ranged from 200 to 350. The mines faculty, prominent engineers from various parts of the country (including British Columbia and Alaska), gave lectures and laboratory demonstrations. Other features were motion pictures and presentations of new equipment.

The feeling in the 1920s by men of the industry was that their department had made a turnabout. Then, like an explosion that shook the country to its core, the stock market crashed on Tuesday, October 29, 1929. It brought the greatest loss in all financial history including drastic cutbacks at the University.

THE DECADE OF 1930-1940

Following the stock market crash of 1929, the country was wallowing from the depths of the Great Depression, which reached bottom in 1932. By that year it was estimated that all payrolls in Washington State had dropped 50% below their 1929 levels. Economically, the effect on the College of Mines was severe, but the College did survive.

Administrative Ups and Downs

Because appropriations for the University were reduced drastically, and salaries were cut again and again, courses were dropped and others, consolidated. Most shocking was Governor Clarence Martin's insistence that the University's 13 colleges and schools, each with a dean, be consolidated into five. The result in 1932 was the following organization:

College of Arts & Science	Dean Dudley Griffith
College of Engineering	Dean Richard G. Tyler
Graduate School	Dean Frederick M. Padelford
Law School	Dean Harold Shepherd
College of Pharmacy	Dean Charles Willis Johnson

This reorganization seemed to mean the demise of the College of Mines. As Dean Roberts stated, "The College of Mines was abolished in 1932 and its work, in reduced form, was placed in the College of Engineering."

By the next year, however, appropriations began to improve, and, a year later, the University's new President, Dr. Lee Paul Sieg, arrived. Under his leadership, a rearrangement of departments and colleges followed, including the restoration of the College of Mines in 1935. Although the Depression was a deeply disturbing experience, the College of Mines proved resilient and became increasingly productive for the remaining years of the 1930s.

These were years when an increase in the price of gold of 69% led to a large increase in gold mining. In addition, the general recovery brought on new developments in alloys and new techniques in metallurgy, and a revival of building construction renewed the ceramic industries. The College of Mines kept pace with industry by educating students to meet new challenges and continued its success in placing graduates; nearly all had jobs by commencement time.

Curriculum and Students

In keeping with the demands of the industry, the curricula continued to grow. The three fields, mining engineering, metallurgical engineering and ceramic engineering each led to a bachelor of science and a master of science degree (the separate degree program in coal mining engineering was a victim of the 1932 reorganization). Apart from basic courses in each specialty, students were given studies essential to the full curriculum from nine other academic colleges and departments on the campus. These included courses in chemistry, geology, civil engineering, general engineering, electrical engineering, science, physics, English and mathematics.

Enrollments grew through the decade, from 47 students enrolled in 1930-31 to a high of 123 in 1937-38. With the addition of master's degree programs, an average of 5 graduate students were included in the student count each year. During this period, students in the graduate program were able to participate in a number of important research programs. Many were supported by the U.S.. Bureau of Mines. As Professor O. J. Whittemore explains:

> Each year the Northwest Experiment Station gave 4 graduate fellowships, each good for 12 months, two in metallurgical engineering and two in ceramic engineering. These were for research, and engineers at the Bureau were involved with the faculty on the research programs. Studies included ceramic minerals in the Pacific Northwest such as clays, olivine, diatomite, magnesite, chromite, talc and glass sand. The 1941 Tyee was devoted to research, and Carl Zwerman and his student George Eyerly were featured for their work on diatomite.

Notable graduates in this period include George Middleton, (1933, M.S. 1934) and William Brandt, (1935, M.S. 1936) in Ceramic Engineering, Paul Duncan (1939) in Metallurgical Engineering, and Richard York (1937) and Russell Wayland (1934) in Mining Engineering. Mr. Wayland's father had also been a graduate of the School of Mines (1906). Phil Holdsworth (Min. E 1937) and Tom Pittman (Met. E. 1932, M.S. 1933) played important roles in the development of minerals in Alaska. Oscar Wicken (Met. E, 1938) worked in South America in minerals

extraction. Martin Chamberlain (Min. E. 1936) became Dean of University Extension at U.C. San Diego and is now President of the University of the World, which develops educational programs in developing countries.

Joseph Pask (M.S. Cer. E. 1935) went on to develop the ceramic engineering program at U.C. Berkeley and was awarded the College of Engineering's Distinguished Alumnus Award in 1991.

Faculty

Until 1937, the College of Mines faculty still consisted of the same four men, Dean Roberts and Professors Corey, Daniels and Wilson. This was a small staff with many responsibilities.

In 1933, an extraordinary session of the State Legislature authorized a State Planning Council, to which the governor appointed nine business executives. This council set up an advisory board. Those named from the University were Professor Hugo Winkenwerder as adviser on forestry, Professor Carl E. Magnusson, on power, and Dean Milnor Roberts, on coal and industrial minerals. In turn, other professors were selected to assist them. All made appearances throughout the state, stimulating men to engage in new businesses.

Assistance for the faculty finally came toward the end of the decade. In 1937, O. J. Wick, was added to the faculty as an Associate in Mining Engineering and Mineral Dressing. Professor Wilson, who received his honorary degree of doctor of science from the Montana School of Mines in 1938, left that year to supervise the U.S. Bureau of Mines Laboratory in Norris, Tennessee. Wilson was replaced by Dr. Carl Henry Zwermann, who joined the University as director of Ceramic Engineering; Zwermann is fondly remembered by his students for taking them skiing and mountain climbing as well as to numerous ceramics meetings. Wendell P. Keith also joined the faculty in Ceramic Engineering in 1939 as an Assistant Professor.

By having the mining students take classes from different instructors throughout the University, the mines faculty was able to concentrate on teaching in their specialty areas. They also carried out research projects, wrote papers for publication, took classes to mines and plants, and carried a heavy load of writing replies to technical inquiries (which yearly totaled about 1,200). A considerable amount of practical course work, including laboratories and field work, was required of the students, a fact that many have indicated was of positive benefit to them in their future years.

Reporting for the year 1939-1940, Dean Roberts could write in a positive vein, saying:

> "The enrollment has increased, staff enlarged, investigations broadened, new equipment added, graduates placed rapidly, while the state's production of mineral substances mined has been much larger than ever before."

Special Classes

In the spring of 1932, when the depression hit bottom, the College of Mines was receiving so many inquiries about methods of prospecting for placer gold and hand-methods of mining that it set up special classes in these subjects. The downtown Seattle Mining Club held public meetings calling attention to these classes.

On June 27, 1932, the College held its first placer mining session at the Mines Laboratory, with equipment set up in the courtyard at the rear. With 350 people in attendance, the 36-ft. string of sluice boxes was completely hidden by a tightly packed crowd, while the cradle, the 20 tubs for panning, and the mercury retort were each surrounded by other large groups of people. Sourdough miners explained the equipment and procedures, and most of the afternoon was devoted to practice under the direction of the College faculty and the old-timers.

Similar sessions were held every few days with attendance as high as 400. Metallurgist B. H. Bennetts of Tacoma arranged sessions in the Tacoma Stadium, trucked in the University's equipment, and gave demonstrations for 1,200 people. In Everett, similar instructions were given to 600 men. Altogether, the number of persons receiving instruction on panning for gold reached 3,500.

In the depth of the Depression thousands of people found that any opportunity to earn cash was worthwhile, and greenhorns discovered placer gold in many areas of the state where it had previously been unknown. The U.S.. Assay Office of Seattle and numerous buyers of gold reported receiving far more small lots of gold in 1932 than ever before.

THE DECADE OF 1940-1950

This decade began with a global war, instigated by Adolph Hitler, and related political and economic struggles. The impact of the war was deeply felt at the University. Many students who were drawn off by the war, returned in great numbers at the war's end. This decade also marks the end of the College of Mines as an independent unit of the University and the beginnings of the development of a strong research component in the College's programs.

Students

The College of Mines, which began this decade with a total enrollment of 85 students in 1940-41, watched as student enrollment dropped to six in 1945. However, after hostilities ceased, veterans returned, increasing enrollment in two years to more than 90 students, 90% of whom were veterans. Some returned to continue studies which had been interrupted.

The veterans were enthusiastic students. They brought back accounts of mining regions in distant lands that excited their interest and whetted their desire for a technical education in mining engineering. They also saw a good future. At home, the higher prices of metals and minerals created a demand for graduates with mining and metallurgical experience. Moreover, the metallurgical plants in the state, which had been built for war purposes, were now adapted to commercial operation, with a consequent increase in the need for engineers.

Mining Institute Anniversary, 1946

After the surge of returning veterans, enrollment in the College of Mines sagged, with 51 students, including 13 graduate students, being enrolled in 1949-50. This development, combined with Dean Robert's retirement in 1947 brought about a reappraisal of the future for the College of Mines.

Some of the notable graduates in the 1940s include Bill Greene (1941), James Griswold (1941) and Edwin Bellis (1945) in Metallurgical Engineering, and William Stoll (1940) in Mining Engineering. Carlton Goudge (Cer. E. 1942) worked at Gladding McBean and later was a successful international consultant, while David Pfeiffer (Min. E. 1945) worked in many locations in the U.S. for Chevron. Philip Lindstrom (Min. E. 1941) had a long and distinguished career at Hecla Mining Co., while James Ramsey (Met. E. 1948) had a great influence on ferrous metallurgy applications and the development of new welding technologies at Boeing.

Curriculum

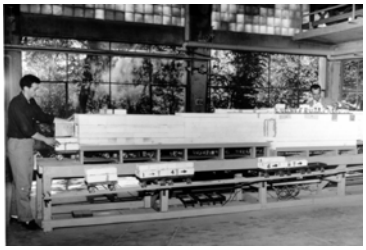
When the war concluded in 1945, the State Legislature, mindful of helping veterans and encouraged by the efforts of the West Coast Mineral Association and others, revived the Prospector's Course that had been given from 1889 to 1923.

Curricular emphasis in the College shifted to a wide range of new studies in the late 1940s. These included properties of new alloys, treatment of ores by new processes, application of cheap electric power to operations in the industry, and utilization of numerous industrial minerals found in the state. Investigations were conducted on a wide variety of minerals, including feldspar, diatomite, pumicite, glass, sand, magnasite, chromite, and olivine. The new curriculum also emphasized work with new analytical instrumentation that led in the 1950s to the blossoming of the science of materials.

Facilities

Responding to the needs of the construction industry, the State Legislature provided funds for the construction of a new Kiln Building (now the Wilson Ceramic Laboratory), which was completed in February of 1946. Responsive to the needs of industry for ceramic studies, the building was the only one of its kind in the Far West.


Kiln Building, 1946

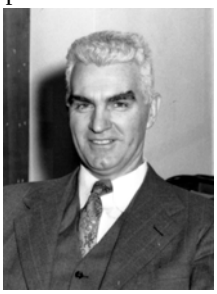

Tunnel Kiln

The building housed six kilns of different types for studies both in refractories and in pottery, clays, terra cotta, and other building wares. Situated behind the larger Mines Laboratory building, it complemented valuable apparatus in the Laboratory, such as test ovens, a coal washing jig, a 222-ton brick press, and other more traditional equipment. The Kiln Building was the first on the campus to have portions of its walls made of glass bricks, a product of ceramic studies.

Faculty

In 1941, Dr. Joseph A. Pask, who had received his M.S. degree from the College in 1936, joined the Washington faculty. He became head of the Ceramic Engineering Program, replacing Zwermann who went on leave to serve in the U.S. Army. Pask later earned his Ph.D. at Illinois, following which he developed the Ceramic Engineering Program at the University of California. The year 1943 saw both Professors Pask and Keith leave the Ceramics Program, Keith joining the Manhattan (atomic bomb) Project.

In 1945, Drury A. Pifer was appointed as Associate Professor. Pifer came to the University with a rich history. He had extensive mining experience in Alaska, British Columbia and Idaho and more than 14 years in management positions for Sub Nigel, Ltd. and DeBeers Consolidated Mines, Ltd. of South Africa. When Milnor Roberts retired in 1947, Pifer became director of the renamed School of Mineral Engineering. He served in this capacity for 21 years.



Drury Pifer

In 1946, Professor Carl Zwermann, now a Lt. Colonel, served as governor of Kenywon Province, Korea. He returned to his position as director of Ceramic Engineering in 1947 and retired in 1949. He was replaced by James I. Mueller.

Professor Corey retired in 1947. It was during this same year that Donald L. Anderson joined the University as Instructor in Mining Engineering. Anderson left the University in 1949 and returned again in 1953.

In 1949, James I. Mueller joined the faculty of the Ceramic Division of the School of Mineral Engineering after receiving his Ph.D. from the University of Missouri. He later was Chairman of Mining, Metallurgical, and Ceramic Engineering from 1970-1973.

Faculty appointed late in the forties to replace departing members and to enhance the curriculum included George Eyerly and Peter D. Johnson in ceramics, M. S. Pechet in mining, and H. G. Poole, F. Aplan, J. A. Finley and E. A. Rowe in metallurgy.

Roberts' Retirement

Dean Roberts retired in 1947 after serving as professor and dean for 46 years. Almost immediately, in recognition of his service, the regents renamed the Mines Laboratory as Roberts Hall in his honor.

Roberts was well loved and respected by his students. Alumnus James Griswold, a student in the late thirties and again in the late forties, writes:

> "I remember Dean Roberts with great affection and love. He pushed me when I thought I couldn't go another day and literally made me graduate. His (museum-like) house was at the top of the campus...with his pitch-and-putt golf course well hidden across the street by a tall hedge. (In the) summer of '47, the new University President came to a barbecue there (all us students, mostly grad students, had to act as hosts and guides). Dean Roberts usually held 3 or 4 parties (a year) at his house and it was a great honor to be invited. At that time, most of us "students" were ex-service and in our late 20s (or) early 30s. The Annual Mining Congress was hosted by Washington in 1946 and again we hosted. President Hoover attended and it was a thrill to hear President Hoover and Dean Roberts greet each other on a first name basis."

Roberts had an illustrious career, becoming one of the most knowledgeable men on ore deposits and mining practices on this continent. His work had carried him to Brazil, Bermuda, Hawaii, Alaska, Canada, Europe, and of course to all parts of the United States. Friendly to all, he loved to entertain students and mining friends at his home, often serving barbecue dinners in his yard. After retiring, he maintained a busy consulting practice to round out his long career. Years later, his sister Milnora funded a conference room and lounge in Wilcox Hall as a memorial to him.

Enrollment had been small for many years, never growing much past the 100 student mark, and similarities in courses and interests suggested that much might be gained by combining the College of Mines with the much larger College of Engineering. Accordingly, by an action of the regents in 1947, the College of Mines was renamed the School of Mineral Engineering, and given a status in the College of Engineering similar to that of its other departments. Drury A. Pifer was appointed its Director, reporting to Dean E. A. Loew of the College of Engineering.

Following this consolidation with the College of Engineering, the new School entered a period of expanding graduate studies, an increasing interest in Metallurgical Engineering and Ceramic Engineering, and a declining interest in Mining Engineering. In the state, there were few new mines and many were closed due to changing economic conditions. On the other hand, the development of new metallic alloys and new ceramic materials with enhanced properties provided a base for continued growth of research into the following decades.

THE DECADE OF 1950-1960

Nationally, the 1950s saw a strong growth in the science of metals and an enhancement of the instrumentation that was available for the analysis of properties of ceramics and metals. In both the School of Mineral Engineering and the College of Engineering, new research and graduate study orientations led to a variety of faculty changes. These new directions were the result of changes at the top, especially the appointment of Harold Wessman as Dean of the College of Engineering. Dean Wessman was convinced that the College needed to emphasize research to gain its proper place among the top engineering schools in the country.

The School of Mineral Engineering during this period was administered as 3 divisions, Mining Engineering, Metallurgical Engineering and Ceramic Engineering, each with its own division head. There was little crossover between disciplines by either faculty or students.

In 1955 the Kiln Building was renamed the Hewitt Wilson Ceramic Laboratory in honor of former Professor Hewitt Wilson and in recognition of his work in establishing the Ceramic Engineering Program.

Prof. James Mueller (l) & Mrs. Willson at dedication of Wilson Hall Dedication, 1955

Curriculum and Students

The enhancements in the science of metals and the development of new analytical tools in the materials area were reflected in upgraded curricula in the School. This included both new courses in properties as they relate to structure and courses relating to means for determining both structure and properties of these materials. The 1950s also saw the re-development of curricular activities that are still in place today, including field trips and senior seminars. In the ceramics curriculum, courses on refractories, processing, and analysis were offered. In metallurgy, courses included mineral dressing, extractive metallurgy, and classes on specific alloy systems.

During this period, total enrollments rose gradually from 47 in 1950-51 to 101 in 1959-60. This included 44 students in ceramics, 41 students in metallurgy and 16 students in mining. The graduate enrollment increased from 16 to 36 over this time period. As welcome as it was, this growth did place a strain on space for classrooms, laboratories, and faculty.

Students in the 1950s have been called the "apathetic" generation, especially in comparison with the "activist" generation that followed them in the 1960s. However, the students in the School of Mineral Engineering worked hard during the 1950s and developed the basis for their considerable accomplishments in future years. As with the students before them, many distinguished themselves as entrepreneurs in the development of new technologies in metallurgy, ceramics, and mining. The solid, practical basis of their education served them well.

Notable graduates in this decade include Frank Wagstaff (Cer. E. 1959), Vice President of Wagstaff Engineering, a firm manufacturing continuous casting machines; and Gordon Barna (Cer. E. 1957), Vice President for Manufacturing for National Refractories.

This group also includes Robert DuFresne (Cer. E. 1954), Tektronix, retired; and Roger Miller (Min. E. 1952), former President of Windsor Minerals. William Quist (Met. E. 1957, Ph.D. 1974) has distinguished himself in the development of light metal alloys at the Boeing Co., while Donald Bolstad (Met. E. 1959, M.S. 1961) has done

considerable alloy development for the space shuttle at Martin Marietta. Wendell Hurlbut (Cer. E. 1953), current Chief Executive Officer of Esterline Technologies, was named Distinguished Alumnus of the College of Engineering in 1993. Clare Nordquist (Cer. E. 1958), currently the Principal of Materia Ventures Associates, a venture capital fund, was named Distinguished Alumnus of the College of Engineering in 1994.

Faculty

Considerable turnover in the faculty occurred in the 1950s. In 1951, there were two resignations, Professors H. Gordon Poole and P. D. Johnson. Professor Poole, who had taken leave in the late 40s for an assignment in Mexico, resigned to accept a position as metallurgist with the U.S.. Bureau of Mines at Albany, Oregon. Later, in 1954, he was appointed Professor and Head of the Department of Metallurgy at the Colorado School of Mines.

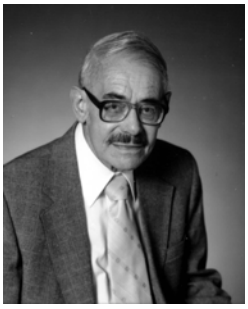
In 1953, M. S. Pechet, instructor in Mining Engineering, left to accept industrial work. His replacement was Donald Anderson, former instructor in Mining Engineering. Mr. Anderson eventually became Professor, acting chairman of the Department in 1968 and retired in 1982.

In 1954, the entire faculty in Metallurgical Engineering required replacement. Assistant Professor Frank F. Aplan resigned to continue graduate study at the Massachusetts Institute of Technology, Assistant Professor J. A. Finley died, Associate Professor E. A. Rowe resigned, and Professor Joseph Daniels retired.

As Professor Emeritus, Daniels was frequently in demand as a consultant in the United States. His publications, especially those on coal resources in Washington, were standard references for many years.

Notwithstanding the attrition within the faculty during the years of 1950 to 1954, the remaining faculty members, Professors Pifer, the Head of the School and Mueller, the Head of the Ceramic Engineering Division, maintained a high level of professional activity and were able to plan for the future of the School's programs by appointing bright new faculty members with excellent credentials. Many of the new appointees now had Ph.D. degrees. These new appointees included Dr. Edward Eugene Mueller, Assistant Professor of Ceramic Engineering, 1953; Dr. Earl C. Roberts, Associate Professor of Metallurgical Engineering, 1953; Mr. Robert J. Campbell, Jr., Assistant Professor of Ceramic Engineering, 1955; Douglas H. Polonis, Assistant Professor of Metallurgical Engineering, 1955; and Alan D. Miller, part-time Instructor in Ceramic Engineering, 1957. Each of the new faculty members took an active part in research and in the development of the graduate program, in addition to undergraduate teaching.

Professor Eugene Mueller conducted research and taught in the Ceramic Engineering Program. He eventually left the faculty (in 1959) and later became the Dean of the New York State College of Ceramics at Alfred University.



Robert Campbell

Professor Campbell's research and teaching interests were in electronic ceramics and processing. Later, he served as Associate Chairman of the Department. After his retirement, Campbell served for a few years in the Engineering Advising Center. Eventually he contributed his estate, over one million dollars, to establish a professorship in Ceramic Engineering. This chair is designated to be filled by a person with industrial experience in the field.

As part-time instructor in Ceramic Engineering, Miller displayed a strong sense of how to balance his interest in people, with his teaching and research work involving X-ray diffraction of ceramic materials. Although he left the University in 1958, he returned again in the 1960s.

Professor Polonis was dedicated to the development of research excellence in physical metallurgy. He helped develop the process of levitation melting during his graduate work, and applied this technique to a number of alloy studies. His research continues today in the area of phase transformations of alloy systems. Dr. Polonis served as Department Chairman from 1969-71 and again from 1973-81.

Professor Earl Roberts was on the metallurgy faculty for nine years. He worked well with his colleagues, participated strongly in physical metallurgy research and published a number of important papers on residual stress effects in metals and alloys.

The remaining new appointees during the fifties were: Frederick B. Brien, who taught and developed a variety of research programs in minerals processing, 1954-75; William F. Flanagan, who taught and did research in physical metallurgy 1959-66; and David W. Morgan, a member of the metallurgy faculty 1959-62.

Now in a new environment, with a new generation of faculty in place, Professor Pifer summarized the School's change in philosophy in a report published in the October 1953 Trend:

> "With the passing of the rich and abundant resources of easily discovered ores from which metals were extracted and exploited during the past century, we are faced with the necessity of applying a higher degree of science and technology to the mineral industry."

Research

With the appointment of new, research-oriented faculty, local industries awarded the School research contracts and funded new laboratory apparatus. This research increased the number of students taking graduate work and earning advanced degrees, and brought a new vitality to the School of Mineral Engineering.

The range of research directly reflected industrial interests and problems that led to the development of such new areas as abrasives; enamels for heavy duty use inside housings of pumps; thermal insulation with stable glass fibers; and insulation with extreme chemical stability. Other areas included furnace linings with thermal shock resistance, low thermal conductivity and extreme refractory qualities; and high lead content glass windows up to five feet thick for shielding nuclear "hot-cells", yet with 80% visible light transmission.

JamesI. Mueller

Professor James Mueller established an X-ray Diffraction Laboratory, which gained considerable recognition. With X-ray spectroscopy, Prof. Mueller had developed methods that had reduced the time for analysis of ceramic materials from days to a few hours. With X-ray diffraction, the physical structure of ceramic materials is revealed, showing the atomic arrangements and crystalline modifications. Studies were made on silica sands, diatomaceous earth, chromate refractories, olivine, and clay. Such studies contributed to the industrial development and technology in Washington. For his work, Mueller, was invited to lecture many times at X-ray diffraction schools in San Francisco and New York.

In recognition of his work, Professor Mueller became a Fellow of the American Ceramic Society in 1959 and was elected Vice-President from 1959-60. In 1958, he was elected President of Keramos, the National Ceramic Engineering Professional Fraternity, a position he held through 1960.

Toward the end of the decade, the newer faculty were also able to secure research contracts. Examples include the grants secured by Professor Polonis from both the National Science Foundation and the Atomic Energy Commission for research in metallurgy, and Professor Earl Roberts' contract from the Boeing Company for studies on stress in metals.

The development of externally funded research programs, which enhanced graduate populations and enabled the faculty to incorporate research findings into undergraduate training was the most important legacy of this decade, as this tradition has carried on to the present. It allowed the School and its faculty to prepare itself for the expansion of research seen in the 1960s while maintaining its high quality undergraduate programs.

THE DECADE OF 1960-1970

In 1957, the Soviet Union had launched Sputnik, the first artificial satellite of the earth. This feat captured the attention of the world and began a process in which more scientific content was introduced into engineering curricula and in which government research funding increased dramatically. This single event permanently changed the face of both education and research in minerals and materials and enhanced the development of the Department over the next two decades.

The 1960s were prosperous years, in which Western Washington's economy was further stimulated in 1962 by Seattle's highly successful Century 21 Exposition. Student activism and protests associated with the U.S. participation in the Vietnam War posed problems for the University, although not directly for the School of Mineral Engineering.

For the School of Mineral Engineering, the decade 1960-1970 was noted for the development of a large research program sponsored by the National Aeronautics and Space Administration (NASA). The program assisted in convincing the State Legislature to appropriate funds for construction of a new 3-floor laboratory addition for Ceramic and Metallurgical Engineering and aided in the addition of excellent research equipment, including an electron microscope. The School was authorized to prepare doctoral candidates in Metallurgical Engineering and

Ceramic Engineering, while the Nining Program continued to shrink. At the end of the decade, the School of Mineral Engineering was reorganized into the Department of Mining, Metallurgical, and Ceramic Engineering.

Curriculum

In 1961, when the University celebrated its first 100 years, accounts were written on the role of each department of the College of Engineering and printed in The Trend of Engineering. In a preface, Dean Wessman succinctly stated the mission of the College: (1) to provide a strong undergraduate engineering education; (2) to provide a stimulating program for graduate studies and research with the potential to complete such a program successfully; (3) to permit outstanding students to realize their full capabilities and develop those qualities that will eventually make them leaders in their profession; and, (4) to inculcate in all students the desire to read, study, and progress professionally "on their own" in their chosen field after graduation. For the School of Mineral Engineering Professor Polonis pointed out that

> Unique to this period was that scientific advances transformed the status of metallurgy from an engineering art to an applied science… consequently the curriculum requires extensive study of physics and chemistry... of solids and fluids, crystallography, solid-state theory, thermodynamics, and transport and rate processes.

The University authorized the Ph.D. for Metallurgical Engineering in 1961 and the Ph.D. for Ceramic Engineering in 1963. The first two doctoral degrees, in Metallurgical Engineering, were awarded in 1965 to the following:

Kenneth R. Evans	Metallurgical Engineering	1965
M. Bud Kasen	Metallurgical Engineering	1965
Donald J. Bailey	Metallurgical Engineering	1966
Fennimore N. Bradley	Ceramic Engineering	1966
Pei Sung	Ceramic Engineering	1967
Richard H. Erickson	Metallurgical Engineering	1967
Alan D. Miller	Ceramic Engineering	1967
Luis W. Pommier	Metallurgical Engineering	1967

Curricula in the Metallurgical and Ceramic Engineering programs were reoriented during this decade to emphasize more science, more experience using analytical equipment, and more basic understanding of the behavior of metals and alloys and of ceramic raw materials and ceramic products. This was made possible by the advanced research findings that were being transferred from graduate research programs and infused into the undergraduate curriculum. The School's undergraduate programs maintained their emphasis on materials processing, including mineral extraction, chemical metallurgy and ceramic processing, as well as their laboratory orientation.

Because students were losing interest in Mining Engineering, a shared program was set up by three northwest universities and five mining companies. It provided 6-months of employment for students to give them underground mining experience to go along with their educational program. It was met with enthusiasm, but provided only a temporary boost in enrollments for Mining Engineering.

Students

Enrollments in the 1960s was in the 120 to 160 range, including an average of 28 graduate students. Undergraduates in 1965-66, for example, numbered 89, including 44 in Ceramic Engineering, 32 in Metallurgical Engineering, and 13 in Mining Engineering. Graduate students that year numbered 20 in Ceramic Engineering (including 8 Ph.D. students), 29 in Metallurgical Engineering (with 13 Ph.D. students) and 4 in Mining Engineering.

Distinguished graduates in this decade include Fritz Wolff, 1964, Manager of Quality for Boeing's 777 program and Eleanor Green Christianson, 1964, Shoreline Community College Instructor, in Ceramic Engineering; Willis Beach, 1962, M.S. 1965 in Mining Engineering; and Larry McKnight, 1960, metallurgical consultant, and George Guilmet, 1969, Professor of Comparative Sociology at the University of Puget Sound, in Metallurgical Engineering.

Tom Delimitros (Cer. E. 1963, M.S. 1966), Principal in AMT Venture Partners, was awarded the College of Engineering's Distinguished Service Award in 1993 for his work in the development of private funding and new research ideas for the Department.

James Williams (Met. E. 1962, Ph.D. 1968), former Dean of Engineering at Carnegie Mellon University and current Manager at General Electric, received the College of Engineering's Distinguished Alumni Award in 1992.

Facilities

Although Mining Engineering no longer attracted students and suffered a decline in enrollment, the two other branches, Metallurgy and Ceramics, showed vigor and growth in students and research, and had a serious need for space and equipment. Relief came in 1964 when the Roberts Addition (now Wilcox Hall), was completed. It was a three story building for laboratories equipped with modern facilities. Additional space also became available when the U.S. Bureau of Mines Northwest Experiment Station, now consolidated with the Bureau's lab at Albany, Oregon, moved out of its space in Roberts Hall.

Important new equipment came with the new building, including an electron microscope, a microprobe analyzer, additional X-ray diffraction units, ceramic processing equipment, mechanical testing machines, a helium leak detector, high frequency power generators with zone refiners and levitation melting apparatus, rolling and swaging mills, and a unique high-temperature micro-deformation facility. In addition, the laboratories were designed so that air could be filtered and conditioned in order to facilitate the use of precision instrumentation in research.

Roberts Addition (now Wilcox Hall)

Of particular importance in the long range was the development of electron microscopy. The JEM-6 high performance electron microscope was added in 1964 to the research facilities of the School of Mineral Engineering. It was one of the first of these models to be installed in the United States. Its resolution power is 4.5 Angstrom units and made possible the direct observation of atomic-scale defects in crystalline materials. In later years, this facility would be upgraded with the addition of several new electron microscopes. Currently available resolution is 1.7 Angstroms, capable of resolving crystal lattice planes.

Faculty

Gifted researchers and instructors of the 1950s, including Professors Douglas Polonis, Earl Roberts, and James Mueller, had rich opportunities to build prestige, so that by the 1960s larger projects came their way. These projects were supported by grants from Boeing and from the National Science Foundation (NSF) and NASA.

In order to continue to develop research projects, as well as to instruct and advise graduate students, it became necessary to appoint new faculty. Twelve faculty members were added in the 1960s. Of these, six developed long-term academic careers at Washington. These were:

Thomas F. Archbold	Metallurgical Engineering	1961-present
Osgood J. Whittemore, Jr.	Ceramic Engineering	1964-1987
William D. Scott	Ceramic Engineering	1965-present
Thomas G. Stoebe	Metallurgical Engineering	1966-present
Alan D. Miller	Ceramic Engineering	1967-present
David B. Fischbach	Ceramic Engineering	1969-1992

All of the new appointees made special contributions to research. Dr. Archbold took charge of the electron microscope for materials studies and later developed a program studying diffusion in order-disorder arrays. Before his appointment, Dr. Fischbach had been on the research staff of the Jet Propulsion Laboratory, where he was an authority on the nature and properties of carbon and graphite, work that he continued at Washington. Dr. Miller's research concentrated originally on the electron structure of ceramic materials, while Dr. Scott's research included work on alumina bicrystals. Mr. Whittemore's research area was ceramic processing, which grew in importance in the Department, while Dr. Stoebe worked originally on mechanical and optical properties of non-metallic materials.

Other faculty appointed during this period included the following: Clyde E. McNeilly, 1960-63, Thomas S. Shevlin, 1961-1964, Barry Lichter, 1964-1968, Jerry Turnbaugh, 1964-68, Henk I. Dawson, 1966-1973, Richard R.

Zupp, 1968-1972, and John H. Jones, 1969-76. Shevlin, upon becoming Associate Professor in 1963, took an active part in organizing research sponsorship by NASA.

In 1960, Professor O. J. Whittemore was elected Fellow of the American Ceramic Society.

In 1962, James Mueller was elected General Secretary of Keramos, the National Ceramic Engineering Fraternity, a position he held until 1974. In 1969, Keramos awarded him the Greaves-Walker Roll of Honor for service to the Fraternity. Also in 1969, the James I. Mueller Scholarship Endowment was established by a group of Professor Mueller's former students to commemorate the 20th anniversary of his coming to the Department.

The celebration of the Ceramic Engineering program's 50th anniversary was held in 1969. Speakers included Dr. Edward E. Mueller, Dean of the New York State College of Ceramics at Alfred University and former faculty member. Other former faculty present included Dr. Carl Zwermann, Dr. Clyde E. McNeilly, Dr. Joseph Pask, and Mr. Wendell Keith.

Ill health interrupted Professor Pifer's career in 1968. He was able to return to work in 1969; he retired in 1970.

NASA Research Program in Ceramic Engineering

During the 1960's support for research from government and industry was relatively plentiful. For example, in the fiscal year 1963-64, grants, contracts, fellowships, and gifts to the College of Engineering had grown to $3 million. Included was $500,000 as the first annual grant from NASA for ceramic materials research.

Monetary support from NASA was obtained as the result of a proposal initiated by Professors Thomas Shevlin, James Mueller, Clyde McNeilly, and Robert Campbell of the Ceramic Division of the School of Mineral Engineering. The proposal was for research on the fundamental characteristics and behavior of ceramic materials. The $500,000 became the first of a series of supplements received over a 25-year period, during which total NASA funding exceeded $15 million.

Problems of interest to NASA included the understanding of the behavior of specialized materials needed in space exploration and in industry. Specifically to be considered were newer ceramic substances such as oxides and carbides that were workable at low pressures and temperatures but stable at high temperatures, and demonstrated a satisfactory ratio of strength to weight. As Dean Harold E. Wessman pointed out, the research was intended to be a focal point for expanded research and training, and would involve all branches of engineering as well as chemistry, physics, and mineralogy. Graduate student training also was included as a significant part of the program.

A separate but related research project for NASA was to assist in the development and testing of ceramic insulation for thermal protection of a space shuttle. For this work, Professor Mueller along with Professor John Bollard of Aeronautics and Astronautics were co-Principal Investigators. Their group studied tiles of ceramic fibers that could withstand temperatures up to 3,000 degrees F to be generated on reentry into the earth's atmosphere. Also included in the study was the question of the best means of adhering the tiles to the shuttle body. The Washington team had to assure NASA that 30,000 ceramic heat tiles would protect the shuttle and its crew under the assumption that the loss of one tile would destroy the ship. The results of this study were incorporated in the original thermal protection system used by NASA on the space shuttle.

Metallurgical Research

Research in the Metallurgical Engineering area was greatly aided by the enhanced research facilities that became available during this period. The Atomic Energy Commission awarded funding over a 15 year period for research in physical metallurgy under the supervision of Professors D. H. Polonis of Metallurgy and R. Taggart of Mechanical Engineering. Their research included, among related subjects, the effects of constitution and microstructure on the behavior of superconducting alloys. Additional support for alloy research was awarded to these investigators by the Office of Naval Research, The Boeing Company and the National Science Foundation (NSF).

In 1967, Professor Thomas Archbold became the Principal Investigator for the National Science Foundation's sponsored study of diffusion in order-disorder arrays in 1967. NSF also funded research concerning the influence of lattice imperfections on material's properties to Professor Henk Dawson, and on diffusion studies in solids to Professor Thomas Stoebe.

Administration

In 1962, Dr. Polonis advanced to Professor of Metallurgical Engineering and served as Head of that Division, succeeding Dr. Earl Roberts. In 1964, Mr. Donald Anderson became Professor of Mining Engineering and, in 1968, Acting Head of that Division when Professor Pifer took leave due to illness. Dr. James Mueller served as Head of the Ceramic Engineering Division.

Effective July 1, 1968, the School was reorganized. The School of Mineral Engineering, in existence since 1947, now became the Department of Mining, Metallurgical, and Ceramic Engineering. Each of the three disciplines controlled its own academic programs but their budgets and personnel were controlled at the Department level. This reorganization was undertaken to resolve budgetary problems and divisional conflicts involving curricula and educational philosophy. The Department Chair position was to rotate among the three divisions every two years. As Acting Head of Mining Engineering, Donald Anderson became Acting Chairman of the Department during 1968-1969. Thereafter, Professor Polonis became Department Chairman in 1969, and Professor Mueller, in 1971.

At the end of the decade of the 1960s, the Department had become a strong one, with fourteen regular faculty members, 178 students and nearly $1 million annually in research grants. Among departments in the College of Engineering, it was a leader in research and education. Professionally, its faculty were well established in their fields. The 1960s ended on a high note of optimism for the Department and its programs.

THE DECADE OF 1970-1980

The 1970s began in a recessionary environment; Seattle's economy was especially affected by a serious decline at Boeing. Because of an oil embargo in the Middle East, oil prices were boosted around the world by nearly 400%. This created additional economic pressure and rising unemployment in the United States. Although the recession bottomed out late in 1975, the inflation rate continued to rise. The University was deeply affected by the economic environment.

Because the state was short of funds, the University was compelled to make cuts and adjustments. Some departments and programs were eliminated. Courses were dropped and severe restraints were put on purchases of library books, supplies, and laboratory equipment. Despite the circumstances, in 1979, William P. Gerberding, the newly inaugurated 27th president of the University optimistically declared, "No great university has ever perished!"

Curriculum

During the early seventies, a new College of Engineering curriculum was put into place. The result of several years of planning, this new curriculum emphasized engineering science, eliminated the General Engineering Department in which all freshman engineers had studied, and created a set of required "college" courses for all students during their freshman and sophomore years. These courses included engineering, drafting, computer programming, technical writing, and a series of engineering science courses such as materials science, statics and thermodynamics. Students were not to enroll in engineering departments until they had successfully completed the College prerequisites in their sophomore year.

As part of this change in the curriculum, most sophomore students no longer registered in the various departments. This required some curriculum changes in the Department so that students entering as juniors could acquire the needed background for their professional level courses in metallurgy or ceramics. This curricular change aided the program by allowing community college students to transfer more readily after their sophomore year.

In 1970, it was clear that interest in mining engineering was waning; the Board of Regents, at its December 1971 meeting, took action to drop this academic program by December 1976. While courses were curtailed, the Department made sure that undergraduates with sufficient academic background in mining and geology could complete their programs. Professor Anderson taught the remaining courses.

The nature of both metallurgy and ceramics had experienced rapid changes with the discovery of new materials and processes. As these emerged, new opportunities appeared – for example, the use of waste products, recycling of glass and metals, and the demand for pollution control. These new areas gave rise to new courses such as Pollution Control of Metallurgical Plants, taught by Professor Brien, and to revisions of existing courses to include the new technologies. In fact, it became apparent that, in the future, industry would require more process-oriented graduates.

In 1979, the Department introduced a new series of courses emphasizing design concepts for brittle materials. An outgrowth of the NASA program, this interdisciplinary series was offered to all engineering students who wished to study the properties, processes, and applications of this relatively overlooked class of structural materials. The classes were taught by a team of professors from Aeronautics and Astronautics, Civil Engineering, Mechanical Engineering, and Ceramic Engineering.

Students

The realities of the early 1970s, a sagging economy and fewer engineering jobs, were reflected in a drop in enrollment. Shown below are the undergraduate and graduate student enrollments for the Department of Mining, Metallurgical, and Ceramic Engineering. In the first five years enrollment decreased, although this number includes the removal of the sophomore class from the Department's total in 1971. The latter years of the decade saw a return to more normal enrollments.

Year	Mining		Metallurgy		Ceramics		Total
	UG	G	UG	G	UG	G	
1970	17	3	35	35	62	25	177
1971	10	4	30	26	42	20	132
1972	7	2	26	26	22	19	102
1973	4	1	24	27	20	19	95
1974	5	2	24	19	18	17	85
1975	1	1	25	19	25	19	90
1976	1	2	28	19	33	18	101
1977	1	1	35	22	31	19	109
1978	0	0	36	22	37	19	114
1979	0	0	33	26	36	17	112

One of the notable graduates of this decade is astronaut Bonnie Dunbar, who received her B.S. degree in 1971 and her M.S. in 1975 in Ceramic Engineering. Later, she received a Ph.D. in biomedical engineering from the University of Houston in 1983 (James Mueller was on her doctoral advisory committee by special permission). Dr. Dunbar flew her first Space Shuttle mission on the Challenger in 1985, and has flown three times since, the latest being the STS71 Mission in June, 1995, Americas 100th manned space mission and the first of 7 planned Space Shuttle link-ups with the Russian Mir space station. Born in Sunnyside, Washington, she graduated cum laude, was awarded a NASA graduate research grant in 1973 and 1974, was named Rockwell International Engineer of the Year in 1978, received a Group Achievement Award, and the Skylab Reentry in 1979. She was a recipient of the NASA Flight Medal in 1985. Dunbar has devoted considerable time in her career to being a role model for young students, both relative to microgravity science and to women in engineering. In 1993, Dunbar was voted Engineer of the Year by the readers of Design News. She received the College of Engineering's Distinguished Alumnus award in 1990.

Astronaut Bonnie Dunbar

Faculty

The growth and movement of faculty in the 1970s followed that of the economy and student enrollment. In the early 1970s, when the economy was depressed, student enrollment was down and faculty salaries were stagnant, five of the eleven faculty members hired in the 1960s left. Interestingly, two of them, Henk Dawson and Richard Zupp, left to enroll in a University of Miami medical program tailored for people who already had Ph.D. degrees. Also, Drury Pifer, who had served the University for twenty five years, retired in 1970.

Robert G. Stang joined the Department as Assistant Professor in 1973, replacing Professor Dawson. Additional hiring waited until an increasingly healthy economy, led by an upward pattern experienced in business and student enrollment, finally allowed increases in faculty salaries and new hirings in 1976. New faculty hired were David C. Lynch and Y. Krishna Rao.


Douglas Polonis

In a mutually agreed-upon departure from the original administrative format, Douglas Polonis served as Department Chairman from 1973 to 1981. This was due primarily to James

Mueller's focus on leading the NASA program during that period. From 1971 to 1982, Robert Campbell, Jr. served as Associate Chair.

Existing faculty took study leave during this period: O. J. Whittemore went to Brazil on sabbatical in 1976 to help establish a new ceramic engineering program; Thomas Stoebe had spent a sabbatical year earlier in 1972-73, also in Brazil, studying applications of solid state radiation dosimetry, a subject for which he became well known; and William Scott spent a year in France studying ceramic materials properties.

Using his sabbatical as a base for interactions, Professor Whittemore developed a continuing set of NSF-sponsored collaborative programs for the study of sintering with Professor G. Halsey of Chemistry and Drs. J. Castro and J. Varela from Brazil. These studies helped to establish the scientific basis for sintering of ceramic particles.

Professor Stoebe served as Chair of the North Pacific Section of AIME in 1973-74. He was also co-Chair of the Pacific Northwest Metals and Minerals Conferences held in Seattle in 1974 and 1977. In 1977, in addition to his duties as professor, Thomas Stoebe was appointed director of high school relations for the College of Engineering, an outgrowth of his activities related to high school teacher and student curriculum development. This same year he was awarded a $1,000 prize from the Western Electric Award Fund for excellence in instruction by the Pacific Northwest section of the American Society of Engineering Education.

Professor Scott, who had developed a reputation in the area of studies of alumina bicrystals, was elected Fellow of the American Ceramic Society in 1977.

Alan Miller served as Chair of the American Society for Engineering Education's Puget Sound Chapter from 1975-79. He was also active in the American Ceramic Society, serving as Chair of the 28th Pacific Coast Meeting in 1975, President of the Ceramic Educational Council 1979-80, and as Counselor with the Pacific Northwest Section from 1970-93.

Early in the decade, in 1971, as a result of his role in NASA research, James I. Mueller was invited for a front-row seat at the launching of the manned space craft, Apollo 14. Impressed by the magnitude of the Center and the large cooperative effort, he commented: "This nation can do anything if it decides to get together and do it!"

The Department's ties with other nations through engineering societies held fast. In October of 1979, Dr. Mueller attended the 49th meeting of the structure and materials panel of the NATO Advisory Group for Aerospace Research and Development, held in Cologne, Germany. The meeting included a three-day session on ceramics for turbine engine applications. While in Cologne, Mueller visited the DFVLR Institut der Werkstoff-Forschung, where he talked about the ceramic structural materials program at the University of Washington--a subject he had previously discussed at the United Turbine Company in Malmo, Sweden. Mueller also developed a network of supporters for the Department in Japan during this period.

Professor Mueller served as Treasurer of the American Ceramic Society from 1976-78. In 1978, he was honored by the ACerS as a Distinguished Life Member and, in 1979, was named the John Jeppson Medalist and was also elected Fellow of the American Ceramic Society.

THE DECADE 1980-1990

In 1980, due to yet another recession in the State of Washington, Governor John Spellman declared the state in financial emergency, ordering the University to cut its state-supported spending by 10.1 percent. Said William P. Gerberding, University President, although he preferred optimism:

> The national mood is a period of confusion, uncertainty, a certain amount of cynicism, and a good deal of pessimism and gloom.

The budget situation led not only to serious cutbacks throughout the University, but also to the dissolution of a few departments; operating budget cuts were felt also by the Department of Mining, Metallurgical, and Ceramic Engineering.

Students

Despite the economic difficulties, enrollment in the Department held up well, and graduates were able to find jobs--the job offers were just not as plentiful as in previous years. A tally for undergraduates in each B.S. program and for the combined graduate programs is given below:

Year	BS Met E	BS. Cer E	Graduate	Total
1980	42	44	36	123
1981	44	51	35	131
1982	44	38	37	120
1983	35	41	55	136
1984	48	49	77	175
1985	55	45	74	175
1986	43	50	66	159
1987	36	47	50	133
1988	28	46	71	145
1989	24	57	61	142

The large increase in graduate students beginning in 1983 was due to new faculty coming on board.

The Department produced an average of 40 B.S. degrees annually during the 1980s. This figure makes it the largest undergraduate materials program on the West Coast and places it among the top 10 in the country. At the same time, the Department's population diversified; the number of women increased from one in the 1910s to an average of 25% of the student body by the end of the 1980s.

Faculty and Administration

As a result of advances made in the 1970s, the fields of metallurgy and ceramics were coming together, especially with the development of composite materials. Further, an understanding of materials in the more general sense was becoming more important to industry as well as to government. Realizing these changes, the Department of Mining, Metallurgy, and Ceramic Engineering became the Department of Materials Science and Engineering in 1983. The two remaining undergraduate degree programs, Metallurgical Engineering and Ceramic Engineering, were maintained, but after 1983, the graduate degree programs, both M.S. and Ph.D., were consolidated into programs labeled "Materials Science and Engineering."


Richard Bradt

Dr. Richard Bradt was appointed Professor and Chairman of the Department of Materials Science and Engineering in 1983, replacing Professor Polonis. Prior to arriving at the University, Dr. Bradt had been employed by Fansteel Metallurgical Corporation and served on the faculty of Pennsylvania State University as Head of their Materials Science and Engineering Department. Once at the University, Bradt viewed the recent restructuring of the Department as heralding an increased emphasis on the fundamentals and applications of materials science, and developed increased interaction with industry as well as with other engineering departments.

Recognizing the importance of the Pacific Rim area, Bradt quickly became involved in international conferences on refractories in Tokyo, visiting universities and laboratories in Japan and organizing the 1984 International Symposium on Ceramic Education which featured speakers from 20 countries and was sponsored by the American Ceramic Society. In 1987 he co-edited a book on world-wide ceramic engineering education containing contributions from leading educators in 24 different countries, including the Soviet Union and China. Bradt served as Chairman until 1986, when he was selected to be the first occupant of the Kyocera Chair in Ceramic Engineering, which he filled until leaving the University in 1989.


Thomas Stoebe

Thomas Stoebe became Department Chairman in 1987. He had been appointed Associate Dean for Development and College Relations in the College of Engineering in 1982, then had become Associate Dean for Research. Despite his additional administrative duties, Dr. Stoebe continued to teach and conduct research in electronic and optical materials. He also continued his activities in the area of secondary school minority student program development, specifically as a member of the Washington State Board of Directors of the Mathematics, Engineering, Science

Achievement (MESA) Program, which he had founded in 1982.

In 1982, both Professors Robert Campbell and Donald Anderson retired, Anderson as Professor Emeritus and Campbell as Associate Professor Emeritus. Professor Campbell then returned to the University for a few years to serve in the College Advising Center. Later, in 1987, O. J. Whittemore retired as Professor Emeritus; he continues his relationship with the field today in research and consulting.

Dr. Mueller remained at the University until his death in 1986. During his career he was highly sought after for leadership in national and international professional societies, and was widely honored in his field of ceramics engineering. In spite of all this recognition, however, he is chiefly remembered as an inspiration to two generations of students. He was a supportive instructor affectionately named "Doc" by his students. His popularity also led students to develop a series of practical jokes directed at him, much to the delight of all. Said a colleague, "Of all the professors I have known, he was the most loved by his students."

Although the Department lost some of its talented faculty during the 1980s, it also added new faculty with new ideas. The new appointments in 1983 included Bradt, noted above, and Dr. Ilhan Aksay, who had received his B.S. in Ceramic Engineering in 1967. Other appointees were Mehmet Sarikaya, a specialist in electron microscopy, in 1984; Michael Kaufman, an expert in intermetallic compounds, in 1986; and Christopher Viney, who specialized in polymers and biological materials, in 1987. Theoretician Ryoichi Kikuchi was appointed research professor in 1984.

Bradt and Aksay brought with them established research programs in ceramic materials' properties and processing, and rapidly developed new graduate student research programs. Over the next few years, Aksay's program, in particular, brought in over $1 million annually in research funding, as much as the rest of the Department combined. This led to some distortion of the research balance in the Department but also developed a very solid reputation for the Department as a center of excellence in research in ceramic materials.

As a result of their research activities, several members of the faculty won honors for themselves and for their Department. Krishna Rao was named Fellow of the Institute of Mining and Metallurgy in 1984 and, in the same year, was elected to the Advisory Board of the Journal of Metals. He had published over 100 papers on a wide range of subjects, including metal extraction and chemical metallurgy, catalysis carbon reactions, thermodynamics, kinetics, and vapor phase epitaxy of optoelectronic materials. He also authored a comprehensive text, *Stoichiometry and Thermodynamics of Metallurgical Processes*.

David Fischbach was named Lecturer for 1981 by the American Carbon Society, an honor bestowed upon "an individual who has made distinguished accomplishments in some phase of carbon science and engineering." In 1987 he was invited to Oxford University to participate in an editors' meeting and 25th anniversary of the Carbon Journal, for which he had served as an Associate Editor since 1978. Originally a research faculty member, Professor Fischbach advanced to the regular faculty in 1988.

Other faculty awards, resulting from research and service activities, showed the increasing prominence of the faculty. Dr. Douglas Polonis was elected Fellow of the American Society of Metals in 1985. He also held a U.S. Dept. of Energy Faculty Fellowship appointment at Sandia National Laboratory in 1988 and 1989. Dr. Alan Miller was elected Fellow of the American Ceramic Society in 1986. Professor Miller also served as ACerS vice-president from 1982-83 and chaired the Committee on Section from 1982-84. Dr. William Scott was awarded a Fellowship by the Japan Society for the Promotion of Science in 1985, during which he visited Japan for three weeks to inspect laboratories and to present seminars on his research.

Professor Ilhan Aksay was awarded the first of the new professorships at the University for which the U.S. Department of Energy (DOE) would provide $50,000 in annual support. His selection was in recognition of Aksay's strengths as a researcher and his ongoing work with Battelle Memorial Institute, which operates the Pacific Northwest Laboratories for the DOE. In 1987, Professor Aksay was presented the International Fulrath Award of the American Ceramic Society. Fulrath awardees, chosen from among Japanese and American ceramists, spend time in each other's countries exchanging ideas and information and take part in Ceramic Society functions in the host country.

In 1981, before the first launch of the NASA space shuttle, Dr. Mueller stated "I'd ride it myself, I wish I could!" His confident support of the shuttle project was rewarded in 1982, when he received NASA's Public Service Medal for his leadership in the research: the ceramic heat tiles had done their job of protecting the shuttle and its crew from the very high temperatures during re-entry into the earth's atmosphere. In that same year, he was honored with a State of Washington Resolution for Efforts Relative to the Success of the First Flight of Columbia.

Then, in 1983, he served as Chairman of the U.S. Delegation to the First International Symposium on Ceramics for Heat Engine, held in Hakori, Japan, and was also awarded the Greaves-Walker Award by the National Institute of Ceramic Engineers for his contributions to the profession of Ceramic Engineering. In 1984 he was founder and first president of the United States Advanced Ceramic Association and in 1986 received the Albert Victor Bleininger Award for achievement in the field from the American Ceramic Society. Dr. Mueller also served as president of ACerS from 1981-82.

Research

The research programs at the University continued to be healthy throughout the 1980s. Since the sixties, it had held a position among the top 5 universities (public and private) in the country in terms of federal grants; in the 1980s it climbed to third in the country, and first among public universities. These funds were dedicated to research, so that the research function continued even while the educational function was squeezed. By the late Eighties, the state appropriations for the University made up less than one third of the University budget.

Changes were taking place on the national scene regarding metallurgy and ceramics. Research in these fields was coming together into a better defined field of materials research, especially as composite materials made their debut and as semiconductor device design made use of any and all materials of potential use. In the Department, external funding grew to an average of over $2 million annually toward the end of the decade, assisting the Department in developing high quality graduate research programs.

In January, 1980, a Mining and Mineral Resources Research Institute was established at the University, one of 31 institutions in the United States chosen by the U.S. Office of Surface Mining for such a program. The founding Director was Professor Donald Anderson, who was replaced by O. J. Whittemore in 1982 upon Anderson's retirement. The Institute conducted investigations, demonstrations, research, and experiments related to mining and mineral resources. In addition, it trained students in metallurgy, ceramics, and geology. Funding began at a basic level of $110,000 a year, with an extra $53,000 for scholarship and fellowship funds for undergraduate and graduate students. During its 11 year life, the University's Institute received over $2 million.

The Institute's steering committee, appointed by Dean Dale Carlson of the College of Engineering, included Drs. Krishna Rao, David Lynch, and O. J. Whittemore from the Department, and Dr. Eric Cheney, from the Department of Geology. Faculty from other departments within the College of Engineering taught related courses. Other University departments, such as Environmental Studies and Marine Studies, also participated, as did faculty and students of Washington State University and Eastern Washington University.

Over time, one of the most successful activities of the Institute proved to be the mini-research projects that it funded. Their purpose was to aid the faculty in developing significant proposals for submission to other agencies for funding. The arrangement enabled total research grants and contracts in the Institute to surpass by several times the Institute's funding. Some of the successful proposals called for research on underground coal gasification, biological flow systems, refining of steels, reactivity of coke, refractory concrete, and olivine heat storage media.

The final NASA grant period was 1986-1989. During this period, Richard C. Bradt was principal investigator and the program focused on evaluations of the mechanical and thermal properties of ceramic matrix composite materials. By the conclusion of the program in 1989, NASA had supported over 65 students, faculty, and staff members over the 26 years since the beginning of the program in 1963; NASA had also invested over $15 million in the University. The funding from this program had been a determining factor in the development of the University's leading role in ceramic materials' research, a role which is recognized both nationally and internationally.

In a new program launched in 1988, the University of Washington and the U.S. Department of Energy's Pacific Northwest Laboratories (PNL) signed a memorandum of understanding designed to encourage closer cooperation between the two institutions. It established professorships, graduate fellowships, and research contracts. To date, three Department faculty have held PNL Professorships, and five faculty have been named adjunct faculty at PNL. Several joint research programs have also been developed with PNL in areas including intermetallics, ceramic processing through biomimicking, and solid state batteries.

Facilities

The long awaited renovation of Roberts Hall, home of the Department of Materials Science and Engineering, was begun in 1985. This project, planned in the late 1970s and early 1980s by a committee headed by Professor Douglas Polonis, was the first stage in the development of a set of new and renovated facilities for the College of Engineering.

The first phase of a major facilities project began with the construction of a new building known then as Roberts Underground (now James I. Mueller Hall). The $4 million project was funded by the state and completed in November 1986. This building, located in front of Roberts Hall under the surface level of the former parking lot, is the home of ten laboratories, two classrooms, and an auditorium.

Remodeling of Roberts Hall began in May of 1987. For this remodeling, Roberts Hall was completely gutted, and all interior walls were removed. The building's steel columns were reinforced to bring the 1920s structure in line with current earthquake codes while preserving the original exterior appearance. This $6 million second phase of the Roberts renovation was completed in 1989. During the renovation, the Wilson Ceramics Lab, which had been refurbished, was the temporary headquarters of the Department's staff.

Roberts and Mueller Halls

Upgrading of equipment accompanied the building program. The Department was able to purchase a new scanning electron microscope, a new mechanical testing system, and a new X-ray diffraction facility. Also added to the equipment inventory from research grants during this period were two high-resolution electron microscopes, one for high quality analysis and the other for atomic imaging, and a molecular beam epitaxy system for growth of compound semiconductor devices.

These upgrades made the Department one of the better equipped programs nationally for materials research and education. The overall facilities upgrade gave the Department one of the best physical facilities on campus, both in terms of external and internal appearance and in terms of functionality.

Funding

Because of the growth of other needs and the State of Washington's sagging economy, the state funding base for higher education continued to decline throughout the 1980s as a fraction of the overall state budget. Recognizing that funding for educational quality would have to come from sources other than the state, the Department began to develop external funding for quality enhancements in equipment for undergraduate and graduate educational programs, student scholarships and fellowships, Professorships and Chairs, and overall program development.

In 1985, in recognition of the contribution to ceramic research made by the University and the Department, the Kyocera Corporation, an international electronic and ceramics manufacturer based in Kyoto, Japan, presented the University with $1 million in support of an endowed Chair in Ceramic Engineering. According to Dean J. Ray Bowen, Kyocera saw the establishment of this Chair as a way to thank American customers, who had been instrumental in the company's growth. Two other universities, the Massachusetts Institute of Technology and Case Western Reserve University of Ohio, also received $1 million each for endowed chairs from the Kyocera Corporation.

In 1986, at the dedication of Kyocera's new plant in Vancouver, Washington, University President William P. Gerberding announced that the first appointment to the Kyocera Chair in Ceramic Engineering would be Richard Bradt, Professor and Chairman of the Department of Materials Science and Engineering. Bradt noted that he planned to continue his research into the hardness, deformation, and fracture of structural technical ceramics, but would give up the chairmanship of the Department.

Toward the end of the decade, additional Department needs were defined, and a five-year goal of raising $2 million dollars was set in order to provide students with a high quality education. The monetary needs were defined as follows:

Equipment	$1,200,000	60%
Student Support	300,000	15%
Program Development	500,000	25%
Total	$2,000,000	100%

An initiative to raise these funds was developed in 1988 under the guidance of Department Chairman Stoebe. The steering committee for the initiative included alumni and friends of the Department, with leadership provided by Mr. Tom Delimitros (B.S Cer. E. 1963, M.S. 1966), Mr. Clare Nordquist (B.S. Cer. E. 1957) and Mr. William Payne, a long time student of Prof. James Mueller. The committee initially raised nearly $1.5 million, including $700,000 in equipment (much of it new or nearly-new surplus equipment from industry); a fund for the Norton Professorship, a gift of the Norton Company; and significant funding from alumni and friends and from a number of corporations. This initial support, much of it from colleagues, students and friends of Prof. Mueller, convinced the University to name the Roberts underground addition in honor of Prof. Mueller in 1991. Finally, the overall funding goal was reached when, upon his death in 1992, former Professor Robert Campbell contributed his estate, over one million dollars, to establish the R. J. Campbell Professorship in Materials Science and Engineering.

This fund raising program allowed the Department to develop new programs for students and to enhance its undergraduate laboratories so that it could continue its tradition of hands-on education in ceramics, metallurgy, and materials into the 1990s. Examples, in addition to the new faculty funded by private funds, include the development of an enhanced laboratory in which students learn computer-control of equipment and processes; new facilities for materials processing; and greatly enhanced funding for the Department's scholarship program for students.

This successful fund raising program provided the basis for further program development in the 1990s. It also proved the point that the alumni and friends gained by the Department over its history were loyal and dedicated to the Department's programs and desired to ensure that the Department and its students were funded at the level needed for quality education. A listing of the donors to the Department over its history is given in the appendix to this history.

THE 1990s & TOMORROW

As the 1990s dawned, the national economy went into recession, followed by a period of slow growth. However, the importance of materials in engineering applications was becoming more and more evident, as noted in such national reports as *Materials for the 1990s* by the National Academy of Sciences. This report noted the importance of materials processing and the lack of research and development work in this area, along with the need for the development of new materials with well understood relationships among processing, structure, and properties. This report also led to new national initiatives in the areas of materials development and manufacturing.

That the Department has already contributed to the national understanding and development of new materials is clear from the record of the Department's alumni and alumnae: Over 110 of them living in 1991 (from a total of 1100) listed their job titles as owner, president, Chief Executive Officer, or Chief Operating Officer in firms large and small. This record points to the achievements of an alumni willing and able to lead the nation in advancing the materials field. The record also indicates leadership in research and teaching: At least 33 alumni and alumnae have been elected Fellows of professional societies and at least 31 are current faculty members at colleges or universities.

The Department continues to develop new concepts in education and research by building on the creative ideas of its faculty. New faculty members, who continue to join the Department during the period 1990-1993 will help it to take advantage of developing areas in the materials field. These new faculty members are:

Lucien N. Brush	PNL Professor	1990
Gretchen Kalonji	Kyocera Chair in Ceramic Engineering	1990
Rajendra K. Bordia	Norton Professor	1991
Fumio Ohuchi		1992
Thomas P. Pearsall	Boeing Chair in Semiconductor Electronics	1993
Sossina Haile	PNL Professor	1993

The influence of the Department's private funding is evident from this list. The Kyocera Chair funding allowed the Department to bring Dr. Kalonji on board and to build on her expertise in the new area of computational modeling of materials. The PNL Professorships for support of new faculty aided in attracting Dr. Brush, an expert

in computational modeling of solidification processes, and Dr. Haile, with her expertise in solid state electrolytes and other battery materials. The Norton Professorship allowed Dr. Bordia to join the faculty and to develop his area of composite materials. Dr. Pearsall, holding a Boeing Chair and a joint appointment with Electrical Engineering, is an expert in the growth of new semiconductor device materials using epitaxial techniques. Dr. Ohuchi provides the Department with expertise in surface and interface science, also of direct importance in composite and electronic materials development.

These new faculty have added considerably to the Department's educational program by developing new and revised courses, including new concept courses in introductory materials science, composites, computational modeling, and materials recycling. Prof. Kalonji, in particular, has led a College of Engineering-wide program in educational development which emphasizes the importance of design in engineering education. The addition of these new faculty members also strengthened the Department's commitment to hands-on laboratory education in all aspects of materials science.

In research, these and other new areas of program development such as biomimicking have reinforced the department's traditional strengths in mechanical properties, phase transformations, materials processing, and electron microscopy. Interdisciplinary research continues to be important, including programs with Electrical Engineering in electronic materials, with Mechanical Engineering in composites, and with Forestry and Civil Engineering in materials recycling.

Faculty recognition in the 1990s include Alan Miller's election as president of Keramos, the National Ceramic Engineering Professional Fraternity, for the 1993-96 term. David Fischbach was elected Fellow of the American Ceramic Society, 1991 and Thomas Stoebe became Fellow of ASM International in 1992.

Over its 100 year history, the Department has followed an ever-expanding road of development from its beginnings in the mining of coal, gold, and other minerals and the beneficiation of these ores, to the development of artificial composite and electronic materials with designed properties for high technology structural and device applications. It has had a rich history of interdisciplinary education and research, beginning with its collaboration with Geology, and continuing in the NASA, Mineral Institute and other programs. It has educated several generations of national and international leaders in business and research and has been a major contributor to the development of the economy of the State of Washington and the nation.

The vision and mission of the Department for the 1990s is to continue to serve the industrial and academic needs of the University, the State of Washington, the nation, and the international community by:

- Serving as the focal point and catalyst for the development of high quality, coordinated and visionary research and educational programs for materials-oriented students and faculty throughout the University, and by
- Providing the highest quality educational programs in materials science and engineering for materials professionals at the undergraduate and graduate levels.

It is with this mission in mind that the department is addressing itself to its second century. Based on its broad range of accomplishments, the flexibility it has exhibited in addressing the needs of students and the professional community, and the growing importance of the materials field for meeting national needs, the future of the Department looks bright as it proceeds into its second century.

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APPENDIX I

Biographical Data on Significant Members of the Faculty

Ilhan A. Aksay B.S., Ceramic Engineering, 1967, University of Washington; M.S., 1969; Ph.D., 1973, University of California at Berkeley. Associate Professor in Materials Science Engineering at U.W., 1983; Professor, 1985. Resigned from the faculty in 1992 to join the faculty at Princeton University.

Donald L. Anderson B.Sc., 1938, St. Francis Xavier University of Nova Scotia; B.S., Mining Engineering, 1941, University of Illinois. Instructor of Mining Engineering at U.W., 1947; Took leave in 1949, returned in 1953; Professor, 1964; Acting Chairman, 1968-1969; Professor of Mining and Adjunct Professor of Geological Sciences, 1975. Retired in 1982 as Professor Emeritus, now resides in Arizona and continues to consult on mine development.

Thomas F. Archbold B.S., 1955, M.S., 1957; Ph.D., 1961, Metallurgical Engineering, Purdue University. Assistant Professor of Metallurgical Engineering at U.W., 1961; Associate Professor, 1968, Professor of Mining, Metallurgical, and Ceramic Engineering, 1973. Continues on the faculty today.

Rajendra Bordia, B. Tech., Mechanical Engineering, 1979, Indian Institute of Technology; M.S., Materials Science & Engineering, 1981, Cornell University; Ph.D., Materials Science & Engineering, 1986, Cornell. Research scientist at E. I. du Pont de Nemours & Company, 1986-91. Associate Professor of Materials Science and Engineering at U.W., 1991. Recipient of National Young Investigator Award 1992-97 and Du Pont Young Professor Award 1993-96. Currently on faculty.

Richard C. Bradt B.S., Materials Engineering, 1960, Massachusetts Institute of Technology; M.S., 1965; Ph.D., 1967, Rensselaer Institute of Technology. Professor and Chairman of the U.W. Department of Materials Science and Engineering at U.W., 1983; First appointee to the Kyocera Distinguished Chair in Ceramic Engineering, 1986. He left the University in 1989 to join the University of Nevada.

Frederick B. Brien B.S., Mineral Engineering, 1950, University of Alberta; M.S., Mineral Engineering, 1951, Columbia University. Assistant Professor of Mineral Engineering at the U.W., 1954; Associate Professor, 1957; Professor of Metallurgical Engineering, 1963. He died in 1975 at the age of 57.

Lucien Brush, B.E.S., Materials Sciences and Engineering, 1980, The Johns Hopkins University; M.E., 1984, Ph.D., 1988, Metallurgical Engineering and Materials Sciences, Carnegie Mellon University. Assistant Professor of Materials Science and Engineering at U.W., 1990.

Robert J. Campbell, Jr. B.S., 1939, Oregon State College; M.S., 1954, University of Washington. Acting Assistant Professor of Ceramic Engineering at U.W., 1955; Assistant Professor, 1957; Associate Professor, 1981; Associate Chairman of the Department, 1971-1982. Retired in 1982 as Associate Professor Emeritus. Upon his death in 1992 he contributed his estate, over one million dollars, to establish a Professorship for a person with an industrial background.

Clarence R. Corey Educated at the Colorado School of Mines and the Montana School of Mines, with two years of technical experience. Instructor in Mining and Metallurgy at the U.W. in 1907. In 1914 left for graduate study at Columbia University, then returned. Retired in 1947 due to illness.

Joseph Daniels S.B., 1905, Massachusetts Institute of Technology; M.S., 1908, Lehigh University, where he held an Associate Professorship. Assistant Professor in Mining and Metallurgy at the U.W., 1911. Retired in 1954 as Professor Emeritus, and worked as a consultant in the United States and abroad.

Henk I. Dawson B.S., 1960; M.S., 1962; Ph.D., 1964, Physics, Technical University, Netherlands. Assistant Professor in Metallurgy at the U.W., 1966; Associate Professor, 1969. Left to study medicine at the University of Miami in 1973. Currently practices medicine in Seattle.

David B. Fischbach B.A., 1950, Denison University; M.S., 1951; Ph.D., 1955, Yale University. Research Associate Professor of Ceramics at the U.W., 1969; Research Professor of Mining, Metallurgical, and Ceramic Engineering, 1977; Professor of Materials Science and Engineering, 1987. Retired as Professor Emeritus, 1992. Currently resides in Bellevue and Camano Island.

William F. Flanagan B.S., 1951, M.S., 1955, Mineral Engineering, Massachusetts Institute of Technology. Assistant Professor of Mineral Engineering at the U.W., 1959. Left in 1966 to join the General Motors Research Laboratory, and later the faculty at Vanderbilt University.

Sossina Haile, BS., 1986, Materials Science and Engineering, Massachusetts Institute of Technology; M.S., 1988, Materials Science and Engineering, University of California (Berkeley); Ph.D., 1992, Materials Science and Engineering, MIT. Fulbright Fellow, 1991-92. Assistant Professor of Materials Science and Engineering at U.W., 1993.

John H. Jones B.S., 1964; M.S., 1967; Ph.D., 1969, Colorado School of Mines. Assistant Professor of Metallurgical Engineering at the U.W., 1969; Left in 1976 to work at Boeing. Served as an acting instructor several times, 1982-90.

Gretchen Kalonji, B.S., 1980, Ph.D., 1982, Materials Science and Engineering, Massachusetts Institute of Technology. Assistant Professor at M.I.T., 1982; Associate Professor, 1986. Recipient of Presidental Young Investigator Award, 1984. Kyocera Professor at U.W., 1990. Currently on faculty.

Michael J. Kaufaman B.S., 1979; Ph.D., 1984, University of Illinois. Assistant Professor of Materials Science and Engineering at U.W., 1986. Resigned from the faculty in 1988 to join the faculty of the University of Florida.

Ryoichi Kikuchi B.S., 1942; Ph.D., 1951, Tokyo University. Affiliate Professor of Materials Science and Engineering at U.W., 1984; Research Professor, 1985. He left in 1987 and is currently on the faculty at UCLA.

Henry Landes B.A., 1892; M.A., 1893, Harvard. Professor of Geology and Mineralogy at U.W., 1895-1936; Washington State Geologist, 1901-1921; Dean of the U.W. College of Science, 1913-32; Acting President of U.W., 1914-15; U.W. Dean of Semi-Professional Studies, 1934-35; Vice Dean of U.W. University College, 1935-36. Died 1936.

Barry D. Lichter B.S., 1953; M.S., 1955; D.Sc., 1958, Massachusetts Institute of Technology. Associate Professor in Metallurgical Engineering at U.W., 1964. Left in 1968 to accept a faculty position at Vanderbilt University.

David C. Lynch B.S., 1971, University of Washington; D.Sc., 1976, Massachusetts Institute of Technology. Assistant Professor of Mining, Metallurgical, and Ceramic Engineering at U.W., 1976; Associate Professor, 1982. Left in 1984 to join the University of Arizona.

Dorsey A. Lyon B.A., Stanford, 1898; Assistant in Mineralogy and Assaying at Stanford, 1897-98. Instructor in Geology and Mining Engineering at U.W., 1898; Assistant Professor in Mining Engineering and Metallurgy, 1899. Left in 1901 to continue his education.

Alan D. Miller B.S., 1957, Ph.D., 1967, Ceramic Engineering, University of Washington. Part-Time Instructor in Ceramic Engineering at U.W., 1957; left in 1958; returned as Assistant Professor in Research, 1967; Associate Professor of Mining, Metallurgical, and Ceramic Engineering, 1975; Director of the U.W. Engineering Advising Center, 1978. Elected Fellow of the American Ceramic Society in 1986. Currently serves as Associate Chairman of the Department.

Edward E. Mueller B.S., Ceramic Engineering, 1948, Missouri School of Mines; M.S., 1932; Ph.D., 1953, Ceramic Engineering, Rutgers University. Assistant Professor of Ceramic Engineering at U.W., 1953; Associate Professor, 1956; resigned in 1959; returned as a Visiting Professor, 1981. Recently retired from the faculty of the New York State College of Ceramics at Alfred University.

James I. Mueller B.S., Ceramic Engineering, 1939, Ohio State University; Ph.D., 1949, Ceramic Engineering, University of Missouri. Joined the faculty of the Ceramic Division of the School of Mineral Engineering at U.W. in 1949; Chairman of Mining, Metallurgical, and Ceramic Engineering, 1970-1973. Elected Fellow of the American Ceramic Society, 1979; National President of the American Ceramic Society, 1981-82. Continued as U.W. Professor of Ceramic Engineering until his death from cancer in 1986 at the age of 69.

Fumio Ohuchi, B.S., 1972, M.S., 1974, Physics, Sophia University (Tokyo); Ph.D., Materials Science and Engineering, 1981, University of Florida. Research scientist at E.I. du Pont de Nemours and Company 1981-92. Associate Professor of Materials Science and Engineering, at U.W. since 1992.

Joseph A. Pask, B.S.,1934, Ceramic Engineering, University of Illinois-Urbana; M.S., Ceramic Engineering, 1935, University of Washington; Ph.D., 1941, Ceramic Engineering, University of Illinois-Urbana. Assistant Professor and Head of Ceramic Engineering Program at U.W., 1941-43. Now Emeritus Professor of Materials Science and Mineral Engineering at the University of California at Berkeley.

Thomas P. Pearsall, B.E. Thayer School of Engineering, 1968; Dartmouth College; M.S., Solid-State Physics, 1970, University of London; Ph.D., Applied and Engineering Physics, 1973, Cornell University. Research scientist

AT&T Bell Laboratories, 1973-76, 1981-89. Research scientist, Thomson/CSF, Orsay, France, 1976-81. Boeing Professor of Semiconductor Electronics at U.W., 1989; Director of the Compound Semiconductor Technology Center, Washington Technology Center, 1989-93; Professor of Electrical Engineering, 1989; Professor of Materials Science and Engineering, U.W., 1992; Adjunct Professor of Physics, since 1992.

Drury A. Pifer B.S., 1930, M.S., 1931, Mining Engineering, University of Washington. Associate Professor at U.W., 1945; Succeeded Milnor Roberts as Director of the School of Mineral Engineering, 1947. Retired in 1970 and died in 1972.

Douglas H. Polonis B.Sc., 1951, Metallurgical Engineering, University of British Columbia; M.Sc., 1953, Metallurgical Engineering, University of Toronto; Ph.D., 1955, Metallurgy, University of British Columbia. Acting Assistant Professor of Mineral Engineering at U.W., 1955; Professor, 1962; Chairman of the Department of Mining, Metallurgical and Ceramic Engineering,1969-1971 and 1973-1982. Elected Fellow of ASM, 1985. Current member of the Engineering Accrediation Commission. Continues on the faculty today.

Y. Krishna Rao B.S., 1958, Metallurgical Engineering, Andhra Loyala College; M.S., 1962, Metallurgical Engineering, Banaras Hindu University; Ph.D., 1965, Metallurgical Engineering, University of Pennsylvania. Associate Professor of Metallurgical Engineering at U.W., 1976; Professor,1980. The author of the comprehensive text, Stoichiometry and Thermodynamics of Metallurgical Processes. Continues on the faculty today.

Earl C. Roberts B.S., 1943, Metallurgical Engineering, Montana School of Mines; M.S., 1950; D.S., 1952, Massachusetts Institute of Technology. Associate Professor of Metallurgical Engineering at U.W., 1954; Professor, 1958. Resigned in 1963 to join the Boeing Company. Returned to U.W. in 1972 for a year as Part-Time Professor. Died in 1984.

Milnor Roberts Educated at Hartford, Connecticut, Cutler Academy at Colorado Springs; B.A., 1899, Stanford University, and Instructor for two years while carrying graduate studies in Mining and Geology. Dean of the U.W. School of Mining Engineering and Professor of Mining and Metallurgical Engineering, 1901; Continued as Dean of the College of Mines, 1911. Retired in 1947 after serving the university for 46 years. Died in 1965.

Mehmet Sarikaya B.S., 1976, Metallurgical Engineering, Middle East Technical University; M.S., 1979, Ph.D., 1982, Materials Science and Engineering, University of California at Berkeley. Assistant Professor of Materials Science and Engineering at U.W., 1984; Associate Professor in 1989. Continues on the faculty today.

William D. Scott B.S., 1954, Ceramic Engineering, University of Illinois; M.S., 1959, Ceramic Engineering, Ph.D., 1961, Engineering Science, University of California at Berkeley. Research Assistant Professor and Acting Assistant Professor of Mineral Engineering at U.W., 1965; Assistant Professor of Ceramic Engineering, 1968; Associate Professor, 1970; Full Professor, 1976; Elected Fellow of the American Ceramic Society in 1977. Continues on the faculty today.

Robert G. Stang B.S., 1961, Long Beach State College; M.S., 1965, University of California at Los Angeles; Ph.D., 1972, Stanford University. Assistant Professor of Mining, Metallurgical, and Ceramic Engineering at U.W., 1973; Associate Professor, 1979. Continues on the faculty today.

Thomas G. Stoebe B.S., 1961; M.S. Materials Science, 1963; Ph.D. Materials Science, 1965, Stanford University. Assistant Professor of Metallurgical Engineering at U.W., 1966; Associate Professor in 1969; Professor in 1975; Director of High School Relations for the College of Engineering, 1977; Associate Dean for Development and College Relations in the College of Engineering, 1982; Associate Dean for Research, 1984; Professor and Acting Chairman of Materials Science and Engineering, Associate Dean in the College of Engineering, and Adjunct Professor of Nuclear Engineering, 1986; Chairman of the Department of Materials Science and Engineering, 1987 to present. Elected Fellow of ASM International in 1992.

Christopher Viney B.A., 1980; M.A., 1984, Ph.D., 1983, Metallurgy and Materials Science, Trinity College, Cambridge University. Assistant Professor of Materials Science at U.W., 1987; transferred to primary appointment in Bioengineering and appointed Affiliate Professor of MSE,1990; Associate Professor,1993. Continues on the faculty today.

Osgood J. Whittemore, Jr. B.S., Ceramic Engineering, 1940, Iowa State University; M.S. Ceramic Engineering, 1941, University of Washington; Prof., Ceramic Engineering, 1950, Iowa State University. Associate Professor of Mineral Engineering at U.W., 1964; Professor of Ceramic Engineering, 1969; elected Fellow of the American Ceramic Society in 1960; Director of the Washington Mining and Mineral Resources Research Institute, 1982.

Retired in 1987 as Professor Emeritus. Currently lives in Seattle and remains active in consulting and international travel.

Hewitt Wilson B.S., Ceramic Engineering, Ohio State University, 1913. Assistant Professor of Ceramic Engineering at U.W., 1918; honorary degree of Doctor of Science, Montana School of Mines, 1937. Left in 1938 to join USBM in Tennessee. The U.W. Kiln Building was renamed for him in 1955 as the Hewitt Wilson Ceramic Laboratory. He died in 1953.

Richard R. Zupp B.S., 1962; M.S., 1963; Ph.D., 1966, Stanford University. Assistant Professor at U.W., 1968. Left in 1972 to enroll in a medical program at the University of Miami. Currently practices medicine in Fresno, CA.

Carl H. Zwermann, Director of Ceramic Engineering at U.W., 1938-41. Left the University to serve in the military; returned in 1947, remaining until 1949. Died in 1990.

APPENDEX II

List of Faculty by year of appointment

Henry Landes	1895	-	1936	William D. Scott	1965	-	present
Dorsey A. Lyon	1898	-	1901	Henk I. Dawson	1966	-	1973
Milnor Roberts	1901	-	1947	Thomas G. Stoebe	1966	-	present
Clarence R. Corey	1907	-	1947	Richard R. Zupp	1968	-	1972
Joseph Daniels	1911	-	1954	David B. Fischbach	1969	-	1992
Hewitt Wilson	1918	-	1938	John H. Jones	1969	-	1976
Carl H. Zwermann	1938	-	1949	Robert G. Stang	1973	-	present
Joseph A. Pask	1941	-	1943	David C. Lynch	1976	-	1984
Drury A. Pifer	1945	-	1970	Y. Krishna Rao	1980	-	present
Donald L. Anderson	1947	-	1982	Ilhan A. Aksay	1983	-	1992
James I. Mueller	1949	-	1986	Richard C. Bradt	1983	-	1989
Edward E. Mueller	1953	-	1959	Ryoichi Kikuchi	1984	-	1987
Frederick B. Brien	1954	-	1975	Mehmet Sarikaya	1984	-	present
Earl C. Roberts	1954	-	1972	Michael J. Kaufaman	1986	-	1988
Robert J. Campbell, Jr.	1955	-	1982	Christopher Viney	1987	-	present
Douglas H. Polonis	1955	-	present	Thomas P. Pearsall	1989	-	present
Alan D. Miller	1957	-	present	Lucien Brush	1990	-	present
William F. Flanagan	1959	-	1966	Gretchen Kalonji	1990	-	present
Thomas F. Archbold	1961	-	present	Rajendra Bordia	1991	-	present
Barry D. Lichter	1964	-	1968	Fumio Ohuchi	1992	-	present
Osgood J. Whittemore, Jr.	1964	-	1987	Sossina Haile	1993	-	present

John W. Cahn

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The Decade 1990-2000

As the 1990s dawned, the national economy went into recession, followed by a period of slow growth. The importance of materials in engineering applications became more and more evident, as noted in such national reports as *Materials for the 1990s* by the National Academy of Sciences. This report noted the importance of materials processing and the lack of research and development work in this area, along with the need for the development of new materials with well understood relationships among processing, structure, and properties. This report also led to new national initiatives in the areas of materials development and manufacturing.

As materials science and engineering continued to mature as a field, one distinguishing characteristic of the 1990s decade was an increased focus on interdisciplinary research. The MSE Department started to develop new interdisciplinary research programs in computational materials science, biomimetics, electronic materials, surface science and composites. There was a noticeable and significant shift in the employers of our graduates and students were being recruited by users of advanced materials as opposed to materials processors and traditional materials industries (e.g. Intel as opposed to U.S. Steel). Since there was broad realization of the importance of materials in all engineering applications, increasingly, research in the field was being conducted by a large number of colleagues in other departments. One example was the University of Washington's Engineered Biomaterials Research Center (UWEB). This NSF funded Engineering Research Center started in 1996 and was housed in the Department of Bioengineering.

UW Engineered Biomaterials Research Center

Significant advances in the ability to characterize and manipulate materials and materials systems at different length scales were providing novel and innovative materials solutions. In nanotechnology, the central premise is the exploration of the interrelationship between processing, structure and properties that manifest themselves at the nanoscale. So photonics, optoelectronics were poised to be the next revolutionary technology for computing and communications and the development of new materials and material systems to meet the needs of this technology proceeded at a furious pace. In biotechnology, there was a need for materials solutions for longer lasting implants, scaffolds for tissue engineering, biosensors, and novel diagnostic and therapeutic strategies. New energy and environmental technologies required significant needs for materials solutions in the areas of fuel cells, pollution reduction and energy efficiency. Higher strength and stiffness materials were needed for a variety of automotive and aerospace applications. Finally, significant advances in computational materials science began to provide a different approach to the development of new materials and understanding their performance.

At the start of the 1990's it was evident that the MSE Department contributed to the national understanding and development of new materials from the record of the Department's alumni and alumnae. Of them, by 1991, over 110 (from a total of 1100) listed their job titles as owner, president, Chief Executive Officer, or Chief Operating Officer in firms large and small. This record points to the achievements of an alumni willing and able to lead the nation in advancing the materials field. The record also indicates leadership in research and teaching: at least 33 alumni had been elected Fellows of professional societies and at least 31 were current faculty members at colleges or universities by this time.

During the 1990s private Departmental funding played a role in faculty development. The Kyocera Chair funding, the Pacific Northwest National Laboratory (PNNL) Professorships, the Norton Professorship and the Boeing Chair enabled the addition of several new faculty that added new research direction and added considerably to the Department's educational program by developing new and revised courses, including new concept courses in introductory materials science, composites, computational modeling, and materials recycling.

The vision and mission of the Department for the 1990s was to continue to serve the industrial and academic needs of the University, the State of Washington, the nation, and the international community by serving as the focal point and catalyst for the development of high quality, coordinated and visionary research and educational programs for materials-oriented students and faculty throughout the University, and by providing the highest quality educational programs in materials science and engineering for materials professionals at the undergraduate and graduate levels. It was with this mission in mind that the department addressed itself to its second century. Based on its broad range of accomplishments, the flexibility it has exhibited in addressing the needs of students and the professional community, and the growing importance of the materials field for meeting national needs, the future of the Department looked bright as it proceeded into its second century.

Students

Throughout the 1990s undergraduates received either a Bachelor of Science in Metallurgical Engineering or in Ceramic Engineering. Graduate degrees were awarded in Materials Science and Engineering.

MSE graduates celebrating in front of UW Suzzallo Library

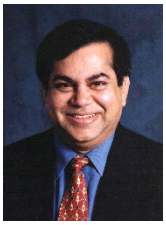
The number of graduates remained fairly constant throughout the 1990s. There was effort to improve diversity in the student population. From 1997 to the end of the decade there was a measurable percentage increase in the enrollment of women (from 15% to 26%) and underrepresented minorities (from 6% to 17%).

Faculty and Administration

Professor Stoebe continued as Chair of the Department through most of the 1990s. The Department developed new concepts in education and research by building on the creative ideas of its faculty. There were five new tenure track faculty members who joined the Department during this time, in addition to three new research (non-tenure track) faculty. Eight established faculty retired or resigned in the 1990s. New faculty replaced the expertise of the older faculty yet also expanded the MSE research and teaching portfolio. With the new faculty hires the Department had a diverse portfolio of materials disciplines and activities. Let's take a look at these new faculty.

Dr. Lucien Brush was hired as the PNNL Assistant Professor in 1990 after receiving his Ph.D. in Metallurgical Engineering and Materials Science from Carnegie Mellon University in 1988 and then spending 2 years in the Applied and Computational Mathematics Division as a National Research Council Post-Doctoral Fellow at NIST in Gaithersburg, MD. Professor Brush brought expertise in modeling melt growth and solidification processes to the Department. In the undergraduate curriculum he was hired to teach metallurgical engineering.

Shortly thereafter, in 1990, Professor Gretchen Kalonji was hired as the Kyocera Chair of Ceramic Engineering. Her PhD and prior faculty appointment were at the MIT. The Kyocera Chair funding helped the Department develop its modeling effort because Dr. Kalonji's expertise was in the new area of computational atomistic modeling of crystalline materials, in materials theory and in rapid solidification processing. This was an exciting time for the Department because the hire of Professors Kalonji and Brush provided the cornerstone for the beginning of materials modeling efforts. Dr. Kalonji was also highly active in education development and innovation. She focused much effort on developing new module-based undergraduate educational platforms through the NSF funded ECSEL program. Dr Kalonji also spearheaded and many international educational collaborative efforts in Africa, China and Japan.



In 1991, Dr. Rajendra Bordia was hired as the Norton Professor. He received his Ph.D. in Materials Science and Engineering from Cornell University in 1987, after which he was employed for four years at the E.I. DuPont de Nemours Company (Dupont) as a research scientist. Professor Bordia's strengths were in ceramic material processing and characterization.

In 1992, Fumio Ohuchi was hired into the MSE Department, also from the Dupont Company. Dr. Ohuchi received his Ph.D. in Materials Science and Engineering from the University of Florida in 1981, and he then spent the following 11 years working as a member of the scientific staff in the Central Research and Development group at Dupont. Dr. Ohuchi focused on ceramic materials in the Department and his expertise in solid state physics, surface and interface science, was of direct importance in composite and electronic materials.

Professor Thomas P. Pearsall joined MSE in 1992, and was the Boeing Professor of Semiconductor Electronics. He hailed from the famous AT&T Bell Labs, and was originally appointed as a faculty member in the Electrical Engineering Department. He was granted a joint faculty appointment in MSE because of his expertise was in semiconductor research including growth of new semiconductor device materials using epitaxial techniques, an area which had a strong collaborative component within the MSE Department.

Dr. Sossina Haile, with expertise in solid state electrolytes and other battery materials, was hired in 1993 as a PNNL Professor. She received her B.S and Ph.D (1992) from the Massachusetts Institute of Technology, and M.S. from the University of California, Berkeley. Dr. Haile carried out postdoctoral research at the Max Planck Institut für Festkörperforschung [Institute for Solid State Research], Stuttgart, Germany in 1992 and 1993 as a Humboldt Fellow. Professor Haile began her career at the University of Washington and in 1996, resigned for a position at the California Institute of Technology.

Dr. Brian D. Flinn became a Research Assistant Professor in 1995. He joined the department in 1991 as a Research Associate. Prior to joining the department, he earned his Ph.D. degree in Materials Engineering at University of California, Santa Barbara, under the supervision of the late Professor Anthony G. Evans. Dr. Flinn became Research Associate Professor in 2002. Dr. Flinn's research at UW covers a variety of materials (metals, ceramics, polymers and composites) with the common goal of improving structural properties by relating the processing to the microstructure and subsequent mechanical behavior. This approach has been successfully implemented in both basic scientific research and applied research with industry. He has been instrumental on developing a strong collaboration with Boeing and many other companies across the US, as well as coaching and mentoring a large number of student group activities within the Society for the Advancement of Material and Process Engineering (SAMPE) and other professional organizations. Dr. Flinn was elected a Fellow of the SAMPE in 2016. In addition, Dr. Flinn is credited for his dedication and service in initiating the Applied Masters Program in the department in 2010.

Dr. Guozhong Cao was hired in 1996. He earned his Ph.D. in Materials Science and Engineering from the Eindhoven University of Technology (the Netherlands) in 1991. Subsequently he was a Research Associate at the University of Twente in the Netherlands from 1991 – 1993, and at the University of Nijmegen, the Netherlands, from 1993 – 1995. He was appointed as a Senior Research Associate, Sandia National Lab and University of New Mexico, from 1995 to 1996. Professor Cao brought his expertise in ceramic processing to the Department where he immediately began programs in sol-gel processes and other material synthesis techniques. Professor Cao is also an outstanding educator and has received many teaching awards.

Closing out the decade of hiring was the addition in 1999 of Dr. Alex Jen as the Boeing-Johnson Chair Professor. He was hired away from Northeastern University and he also had impressive industrial experience as a research scientist. He was the vice president of the New Jersey based ROI Tech company until 1996. Professor Jen was one of the faculty members who would be part of the foundation of the program in polymers. He immediately established an interdisciplinary research group focused on the synthesis and characterization of well-defined, highly functionalized materials for photonics, organic and molecular electronics, and biosensing.

Many distinguished faculty retired during this time frame. In 1992 Professor Dave Fischbach retired, ending his career as an expert on the nature and properties of carbon and graphite, after having initially joined the Department as a Professor of Ceramics in 1969. Professor Christopher Viney. an assistant professor with expertise in polymers, resigned from the Materials Science faculty to join Bioengineering in 1993. Professor Ilhan Aksay resigned to take a position at Princeton University in 1993. Professor Aksay had built a large, well-known Advanced Ceramics research group at the University of Washington, enhancing the legacy of Ceramic Engineering education and research that flourished under the late Professor Mueller.

1995 saw the retirement of Professor Al Miller, ceramic engineer, who was heavily involved in the education and earlier ceramic engineering activities of the Department, followed in succession in 1996 by Professor Polonis, who had built an international reputation as a metallurgical engineer, graduated many students and also served as the Department chair in earlier decades. In 1997, Professor Archbold of Metallurgical Engineering and Professor Scott of the Ceramic Engineering program also retired. These latter four retirements signaled a shift in the Departmental research and education portfolio as their replacements, and others soon to follow, would form the basis of the new undergraduate curriculum established at the beginning of the 2000s, in which the dual Metallurgical Engineering and Ceramic Engineering undergraduate degree programs would merge into one single MSE degree program.

Among the numerous faculty recognitions in the 1990s were Professor Miller's election as president of Keramos, the National Ceramic Engineering Professional Fraternity, for the 1993-96 term and as a fellow of the American Ceramic Society in 1986. Professor Fischbach was elected Fellow of the American Ceramic Society in 1991 and Professor Stoebe became Fellow of ASM International in 1992. In 1994, Professor Kalonji won the George Westinghouse award given by the American Society for Engineering for outstanding contributions to Engineering Education and eventually would earn an NSF Director’s Award for Distinguished Teaching Scholars.

Professor Bordia won the NSF Presidential Young Investigator award which was a highly competitive award for young faculty.

In the spring of 1998, Professor Bordia was appointed Chair of the Department replacing Professor Stoebe. As a part of the transition in leadership, a new strategic plan was developed for the department, taking into account the evolving scope of materials science and engineering within the college and in society. Professor Bordia's vision included growing the Department in new areas, categorized not just by material class but also by research area, and material application focus of the material. This enabled the identification of new opportunities for hiring.

By studying the trends in Materials Science and Engineering of peer programs and by consulting with the Departmental visiting committee and other experts, it became clear that for an optimal future it was critical that MSE develop and expand into a broad-based materials science and engineering department with expertise in inorganic and also in organic (including biological) materials. This was needed to foster interdisciplinary collaboration, stronger research funding and broad-based education for the students in the future. The full integration of organic (including biological) materials into our curriculum (both graduate and undergraduate) would be a major challenge for the future.

Leadership in Research and Education in the 1990s

During the 1990s the Department laid the groundwork for rapid expansion into new areas of research and education. These new areas included polymers, hybrids, biomaterials, nanomaterials, photonic and magnetic materials. Potential applications of nanomaterials, biomaterials, and photonic materials were appearing in modern industry and in cutting-edge technologies. These research areas complemented existing strength in ceramics, metals, electronic materials and composites. Existing interdisciplinary research continued to be important, including programs with Electrical Engineering in electronic materials, with Mechanical Engineering in composites, and with Forestry and Civil Engineering in materials recycling. One of the salient aspects of faculty efforts in the 1990s was the initiation and development of a number of new multi-institutional and multi-Departmental programs led by the faculty of the Department of Materials Science and Engineering in both research and education. Some of the major programs are described below.

Launched 1988, between the University of Washington and the U.S. Department of Energy's Pacific Northwest National Laboratories (PNNL) was a memorandum of understanding designed to encourage closer cooperation between the two institutions that was to continue into the early 1990s. It established professorships, graduate fellowships, and research contracts. As a result, in the early 1990s, three Department faculty held PNNL Professorships, and five faculty were named adjunct faculty at PNNL. Several joint research programs developed with PNNL in areas such as intermetallics, ceramic processing through biomimicking, and solid state batteries, among others.

Pacific Northwest National Laboratories (PNNL)

The ECSEL program was_a 10-year multi-institute (seven schools) program, funded by NSF, which had the dual goals of increasing the design component in engineering education and increasing the diversity of the student body. Professor Kalonji was the Co-Director for the entire coalition from 1990 to 2001. Professor Bordia was the Institutional Co-PI from 1995 to 1996 and 1997-1998; and the PI from 1998 to 2001. Research Professor Brian Flinn was the UW focal point for the K-14 interactions from 1997 to 2001. In addition to the leadership roles, with support from ECSEL, six departmental courses were modified to enhance the design component in them.

Professor Kalonji, also played key leadership roles in the internationalization of education and research. In the Fall of 1998, she was asked by President Richard McCormick to chair a campus-wide body called the International Faculty Council (IFC). The IFC was charged with investigating new models for more effective internationalization of research, education and service. Through the IFC, which existed from 1998 – 2000, more than 70 faculty members and staff were mobilized to work on a variety of projects, including working with the Seattle School District on the internationalization of K-12 curriculum, working with the Association of Pacific Rim Universities (APRU) on programs for the career development of junior faculty and graduate students, and creating new models for integrating international research into the undergraduate curriculum.

In scientific and engineering research, program developments in the area of biomimicking reinforced the department's traditional strengths in mechanical properties, phase transformations, materials processing, and electron microscopy but applied to novel materials and applications. The Molecular Biomemetics program developed by Professor Sarikaya was an effort designed to develop understanding of the mechanisms by which proteins control inorganic materials assembly, morphogenesis and formation through molecular recognition and specific binding. Based on lessons from biology, engineered binding polypeptides were selected and genetically engineered (e.g., using site directed mutagenesis) to tailor their properties for specific applications. Rules for binding of peptides to inorganics (metals, oxides, and semiconductors) were developed. Collaborations resulted in large research, equipment and facility projects originating in the mid to late 1990s and continuing well beyond.

An internationally respected group for performing research on synthesis and characterization of well-defined, highly functionalized materials for photonics, organic and molecular electronics, and biosensing was led by Professor Jen immediately after joining the University of Washington in 1999. This effort was also to continue into the following decades. Because his research was highly interdisciplinary, the group members came from a very diversified academic background, such as chemistry, chemical engineering, materials science, physics, and electrical engineering. In addition, a self-sustaining, state-of-the-art facility for performing chemical synthesis, optical and

electrical characterization, processing, nano-manipulation and imaging, and device fabrication all within the same place was established.

Professor Brush lead the Materials Science component of a funded NSF - Knowledge and Distributed Intelligence (KDI) initiative grant (PI: Jonsson, Chemistry), focused on multiscale modeling of amorphous and crystalline ice. In this work, molecular dynamics calculations, kinetic Monte Carlo simulations, continuum phase field and sharp interface models were used to advance understanding of the growth kinetics and the structure of ice and other materials.

By the end of the 1990s decade the combination of Department retirements and new hires set the stage for subsequent expansion into these and other new research areas into the 2000s.

Distinguished Alumni

During the decade of the 1990s and beyond there are a number of distinguished alumni recognized by the MSE Department as outstanding contributors from the field of Materials Science and Engineering. These individuals have made contributions to our Department, to the University of Washington and to society. The list of Distinguished alumni in this and subsequent chapters is not strictly chronological!

K. Bhagwan "Bud" Das (1971, PhD, Met. 1975) held technical and management positions at the Boeing Co. He was the Quality Engineering Manager for the Boeing 777 program and he contributed to the Department over the years by teaching graduate courses in Composites.

Bonnie Dunbar (1971 BS CerE, 1975 MS Cer E) was one of the Department's most well-known graduates. She flew multiple Space Shuttle missions and would become very active in educational activities and would become the CEO of the Boeing Flight museum. She served on the Department advisory committee.

Wendell Hurlbut III (1953 BS CerE) served as vice-president of Heath Technica Corp, President, CEO and director of Esterline until 1999, when he then became Chairman of the Board. Esterline Technologies, headquartered in Bellevue, Washington, is a diversified manufacturing company servicing major markets in aerospace products, electronics, metal fabrication, defense and public utilities.

Tom Delimitros (1963 BS CerE, 1966 MS CerE) began as a research engineer at the Boeing Company, and then the president of Perolin, Inc, a producer of water treating chemicals. Following this he became President and CEO of Magna Corp. a manufacturer of specialty chemicals. Starting in 1984 Tom worked in the area of venture capital for advanced technology firms and became the Founding General Partner AMT Capital, Ltd. His service to the College of Engineering and to the Department was considerable over 20 years. Tom was one of three people who led the development of the Materials Science & Engineering Initiative, which successfully raised $2.5 million for construction of Mueller Hall and the re-equipping of departmental labs. He continued as an active member on the MSE advisory committee.

James Williams (1962 BS MetE, 1964 MS MetE, 1968 PhD MetE) received all his degrees from the UW. He was an expert in Titanium metallurgy. He would become the President of the Mellon Institute and Dean of the College of Engineering at CMU in Pittsburgh, and then he was the General Manager, Materials and Process Engineering Department, GE Aircraft Engines. Eventually he would become faculty at Ohio State University where he served as Dean of the College of Engineering and the Honda Chair Professor of Materials Science and Engineering. He has also provided great service to MSE.

Frank Wagstaff (1959 BS CerE, 1962 PhD CerE) worked as a research scientist at a number of industrial and governmental research labs, before founding Wagstaff, Inc., a producer of casting equipment for non-ferrous metals and alloys. He received national honors from materials societies for his work. He served for several years on the Department Industrial Advisory Committee, spoke at a graduation reception, and hosted student field trips to Wagstaff Engineering. Dr. Wagstaff and his wife Jane were generous financial donors to the Department.

H. William Kirschner (1939 BS Mining E) was the inventor of the fiberglass ski and founder of K2 Corporation. In 1991, Bill was inducted into the U.S. National Ski Hall of Fame which calls him “one of the great ski entrepreneurs of the 1960's.

Facilities

The Department had a large undergraduate computing facility in 1990, with PCs, Macs, printers and other peripherals for use by students that had been funded by private donations. At that time there were some faculty with Macs or PCs and at the beginning of the 1990s, computing hardware and software technologies were advancing very rapidly. This would result in a paradigm shift in research and educational platforms. For example, the development of the WorldWideWeb and user-friendly web browsing software tools, such as Netscape, would allow wide spread internet access to the public by the mid-1990s. Although the internet had been used by faculty prior to the 1990s, however, Roberts Hall was not wired for internet access until the cable hardware was installed in 1991. This set the stage for Departmental internet connectivity. It also began the downsizing of the centralized UW computing facilities and management at the University, requiring individual Departments to acquire and maintain their own computational resources. As a result, MSE hired staff responsible for computing facilities. Research groups managed their own hardware and software. For example, Sun or Dec workstations were maintained for computation by a few Departmental faculty in their research groups.

The laboratories in the Department of Materials Science and Engineering were also in need of continual upgrades in equipment and facilities to provide for a current, state-of-the-art, first class education for both our undergraduate and graduate students. These laboratories had been upgraded since 1989 as a result of private contributions of $1.5M and funding from the state and federal governments. Expenditures for equipment used exclusively for teaching totaled over $850,000

over the past 10 years. These funds provided for upgrades in the areas of materials processing, computer analysis and control, sample preparation, spectroscopy and analysis, and x-ray diffraction. The computer laboratories for students were continually upgraded to reflect the rapid increase in the computing technology.

Funding

The external support for the Department's research programs remained quite consistent to the end of the decade with research expenditures right around $1.2M per year. The primary sources of the funding were federal research agencies, including the NSF and Department of Defense. State support over the decade increased about 3 percent over the ten-year period. Around 90 percent of the state funding went to faculty and staff salaries and TA support and a small amount went to operations. Equipment and facilities grant and contract awards were a direct result of research collaborations between the UW and other institutions.

The department was also fortunate to have significant support from endowments. As described above, in the early part of the 1990s there were the PNL professorships (later to be PNNL) and the Kyocera Chair. Later in the decade, the primary sources of endowment funds were the Kyocera Chair and the Campbell Chair. Both of these endowments were earmarked for the Department. These endowments paid roughly half the salary of Professor Kalonji (Kyocera) and Professor Krishnan (Campbell). In addition to the endowed Chairs, the department had endowments for student support (e.g. the Mueller scholarship). The support from these sources was close to $200K per year. In the last year of the decade there was approximately an additional 50 percent increase in endowment funding as Professor Jen was named the Boeing-Johnson Chair and about half of his salary came from this endowment. This Chair is designated by the College of Engineering and does not have to reside in Materials Science and Engineering.

The department has strong support from alumni, corporations and foundations. Some of this support was targeted for specific programs (e.g. research in a particular area). The amount of money from development historically has fluctuated from year to year. The Murdoch Foundation funds have supported various purchase in the Department, The other uses of this fund include support for the department, scholarships and fellowships, alumni relations and development activities, publicity of the department, and maintenance and upgrade of the equipment.

The Decade 2000 - 2009

The MSE Department ushered in the new millennium as a student-centered, broad-based materials science and engineering department with educational programs at all levels. The Department continued to be a leader in educational innovation at the undergraduate level by developing novel pathways for international educational experiences for our students. We also continued to be one of the largest producers of undergraduate degrees in the country. From autumn 2001 to summer 2002, we awarded the second highest number of degrees in the country (only University of Missouri, Rolla awarded more degrees). This was quite remarkable considering that the department had one of the smallest faculty nationally. The number of BS degrees per faculty member was almost a factor of 3.75 higher than the average compared to selected peer institutions. At this time the department student body was more diverse, having the highest percentage of underrepresented minorities of any department in the College of Engineering with the percentage of women slightly higher than that for the College of Engineering. In the graduate program, the Department awarded approximately 1 Master's degree and ½ Ph.D. degree per faculty member per year in the 5 years up to 2002, a very good degree production rate.

National and international trends in the field of materials science and engineering were identified from faculty, colleagues and other sources including a report called "International Benchmarking of U.S. MSE Research" (published by the National Materials Advisory Board of the National Research Council in 1998). Trends included an increasing interdisciplinary nature of the field; funding coming from many different sources and collaborations including basic science and engineering, from national labs and industry; the entrepreneurial nature of the researchers driving the field; increased support for collaborative research teams and for research and education integration.

Challenges to the Department at the turn of the century included a lack of faculty members in a few areas which were very important from an educational perspective, but that did not have a strong base outside the department for collaborations. Additionally, there was the need to integrate the needs and expertise of all the faculty members into the educational programs of the department. This was particularly true for organic and biological materials since our department's traditional strength has been in inorganic materials.

Despite these challenges, it was critical to develop a broad-based materials department with expertise in inorganic and organic (including biological) materials. Full integration of organic (including biological) materials in our curriculum (both graduate and undergraduate) was a major challenge. Therefore, the decade 2000-2009 was also a time of transition and expansion of the Department both in education and in research. Near the end of the 1990s, based on the recommendations of the Departmental external advisory committee, and on studies of national trends in the materials science community, the MSE Department faculty decided to transform the undergraduate educational program. By 2002, the two degree programs, the BS in Ceramic Engineering and the BS in Metallurgical Engineering were merged into a single BS degree program in Materials Science and Engineering. The new program curriculum retained its emphasis on experiential learning, research, communication skills, team-based laboratory work and projects but the new program required polymers, composites, biomaterials, among other topics, to be included in an expanded curriculum. The hiring of faculty needed to transition to the single degree program produced a concomitant expansion of research directions into new cutting edge materials

technologies, including photonics, spintronics, biomimetics, medical applications, computation, polymers and more.

Students

The transformation of the undergraduate degree programs in 2002 had a significant impact on undergraduate enrollment. Immediately there was an increase in the quantity and quality of undergraduate applicants. In 2006, the undergraduate enrollment had reached it maximum capacity of ~90 per year, which could not be increased due to limitations of the existing course structures, an out-of-date infrastructure and insufficient Teaching Assistant and technical staff support for the undergraduate (UG) laboratories and other instructional facilities. To address these issues, the Department developed an integrated approach that combined fund-raising to improve infrastructure and to provide student fellowships, streamlining/updating the course curriculum and increasing student advising and technical staff support. As a result, student enrollment was increased even though it was under a period of severe budget cuts (totaling 25-30%) by the State of Washington. The goal was to significantly increase UG student enrollment by the end of the decade.

The integrated approach to the UG curriculum required essential improvements to the curriculum lab facilities, lab support and student counseling. Funding for lab-upgrades and student fellowships significantly increased through concerted efforts by College of Engineering (COE) Advancement, our MSE alumni, staff, and faculty. Efforts from our faculty and staff in leading student technology fee (STF) proposal competition submissions resulted in more than $800K in additional funding that allowed the Department to acquire state-of-the-art equipment and software for the undergraduate teaching laboratories. This funding was especially valuable because it has always been difficult to receive federal or state funds to improve undergraduate teaching facilities. The funding awards not only provided our students with access to state-of-the-art instrumentation and software, but also with new opportunities to integrate knowledge from the classroom with their laboratory and project work in material design, synthesis, processing, and characterization. This integration is the core foundation of MSE and is critical to their future career success in industry and academia.

The number of undergraduate degrees awarded in the years 2000-2009 is given in the Table below. As the result of the change in the degree program, Materials Science and Engineering became an attractive opportunity for more engineering undergraduate students.

Year	BS	MS	PhD
2000	38 (MetE and CerE)	12	6
2001	24 (MetE and CerE)	9	3
2002	29 (MetE and CerE)	5	1
2003	49	13	8
2004	unavailable	unavailable	unavailable
2005	37	unavailable	unavailable
2006	37	4	6
2007	39	3	11
2008	34	1	7
2009	38	4	10

There was a measurable increase in the % of women (from 23% to 31% and under-represented minorities (from 8% to 13%) enrolled during this period. In the graduate program, over the 10-year period, the Department has awarded, on average, 4 PhD's and 9 Master's per year.

In 2001**,** the BS/MS program in Materials Science and Engineering was initiated. This program combined the BS and MS programs of the MSE Department to create a more efficient and continuous academic program that lead directly to the MS degree. The goal of the program was to provide a more direct route to the MS degree for well-qualified undergraduate students who wish for more in-depth, graduate-level work in preparation for work in industry or for a Ph.D. program.

Faculty and Administration

Professor Bordia continued as department chair into the 2000s orchestrating the transformation of the curriculum, leading new fundraising measures for labs and successfully filling strategic new faculty hires. These new faculty hires contributed to the research and educational growth.

In 2000, Dr. Miqin Zhang was hired after having experience as a research scientist at the Zhejiang Research Institute of Metallurgy and receiving her Ph.D in Materials Science and Engineering at the University of California, Berkeley in 1999. With her expertise she soon developed research programs in biomaterials and in many medical fields having materials science applications. Immediately after joining the Department Professor Zhang received a New Century Scholar Award, an Advance Professor Award from the National Science Foundation in 2000 and the NCI Unconventional Innovation Program Award.

Dr. Kannan Krishnan joined MSE in 2001 as the Campbell Chair Professor of Materials Science and Engineering. He came from the Lawrence Berkeley National Laboratory of the University of California, where he was a senior scientist in the Materials Sciences Division. Professor Krishnan brought his expertise in magnetic materials and nanoscience and technology materials science and physics. During his time at the UW, he has received many research fellowships and educational awards as a result of his work in the Department.

The Department expanded its core expertise in polymers science and engineering by hiring Dr. Christine Luscombe in 2006 from the Department of Chemistry at UC Berkeley where she had been the Lindemann Fellow from 01/2004 – 08/2006 after earning her Ph.D. in Chemistry from Cambridge University in the UK. As a young faculty member, Professor Luscombe received both the very prestigious NSF Career award and the DARPA young faculty award. The primary goal of her research effort has focused on the development of controlled polymerizations to synthesize precise polymeric structures and hybrid materials, to enable characterization of novel structure-property relationships. These materials have applications in organic light-emitting diodes, thin-film transistors, and solar cells.

Dr. Marco Rolandi was hired in 2008, bringing to the department expertise in nanoscale phenomena. Dr. Rolandi was hired from the Lawrence Berkeley National Laboratory and the University of California, Berkeley, where he worked as a postdoctoral research fellow, after having earned his doctorate in applied physics at Stanford University. His research focused on schemes to reliably fabricate novel materials for the investigation of nanoscale phenomena. In addition to pursuing his research, Professor Rolandi was interested in developing new classes on nanotechnology for MSE.

All of these additions expanded the Departmental research and teaching portfolio into new areas of polymers, materials chemistry, biomaterials and more. There were departures in the decade of the 2000s as well. In 2001, Boeing Professor Pearsall (also with an appointment in Electrical Engineering) resigned his UW position. Professor of Metallurgy Robert Stang retired shortly thereafter Professor Pearsall left. Professor Stang had contributed to areas of the curriculum related to Mechanical properties. His research interests included superplastic forming.

In 2001, Professor Stoebe retired and became Professor Emeritus. His contributions to the Department are well documented in our history. Since his retirement, Professor Stoebe has remained extremely active in national leadership roles in educational and outreach activities related to Materials Science and Engineering. He has provided gifts to the Department and has founded the Departmental Materials Camp (MatCamp) that runs each summer at the UW. In 2017 he was awarded the College of Engineering's prestigious Diamond award. Finally, Kyocera Chair Professor Kalonji resigned from the MSE Department in 2005 after developing significant international educational programs and winning the very prestigious NSF educational medal.

MSE Materials Camp

Research

By the end of the 1990, the combination of Department retirements and new hires set the stage for subsequent expansion into new research areas into the 2000s. One notable result of the broad-based faculty expertise and the growing interdisciplinary nature of the materials field is that our faculty began to develop more extensive collaborations with faculty members from other departments and outside the University. These collaborations were highly valued because they became a critical component of the department's mission. The complementary strengths within the department and collaborations with colleagues made it possible for us to develop a broad-based research and educational program for our students while maintaining critical size and strength in specific topics. Rapid expansion proceeded into new research areas of polymers, hybrids, biomaterials, nanomaterials, and photonic and magnetic materials with applications in nanomaterials, biomaterials, and photonic materials and in other cutting-edge technologies. These

research areas complemented the existing strength in ceramics, metals, electronic materials and composites.

One example of such collaboration was the participation of the Department in the Center for Nanotechnology (CNT). The CNT is an interdisciplinary center that was created in 1997 with internal University funding (University Initiatives Fund) to support research and education in nanotechnology. In 2000, it received a National Science Foundation Integrative Graduate Education and Research Traineeship Grant (NSF- IGERT). The Center supported graduate students, had a state-of-the-art user facility and supported a seminar series. The Department of Materials Science and Engineering had been a significant part of the CNT since its planning and inception. Initially, eight of the ten tenure-track faculty members from the department were members of the Center. This included all the faculty members who joined the Department since 1990. In addition, in collaboration with Pacific Northwest National Laboratory, a new program called the Joint Institute of Nanotechnology (JIN) was started to enhance collaboration between the PNNL and the UW in Nanotechnology.

MolES Nanoengineering and Sciences Buliding (expansion of CNT)

During the 2000s there were a number of multi-institutional and multi-Departmental programs led by the faculty of the Department of Materials Science and Engineering. Professor Jen, through collaboration with Professor Larry Dalton (Chemistry), established many federally funded multidisciplinary polymer and nanotechnology programs, including an NSF-STC (Science and Technology Center) on “Materials and Devices for Information Technology Research”. The STC had more than 30 faculty participants from seven major universities. The research activities of the STC were (i) theory and modeling; (ii) new material synthesis; (iii) characterization of the optical and electrical properties in bulk, thin films, and nanostructured forms of the new materials; and (iv) device fabrication, performance testing, and optimization of processing techniques. The STC was a multidisciplinary interaction across the fields of chemistry, physics, optics, electrical engineering, and materials science. Professor Jen was a co-PI in other programs including the National Institute of Health (NIH) Microscale Life Sciences Center grant which was a NIH National Human Genome Research Institute Center of Excellence in Genomic Science and was funded for multiple 5 year periods.

Professor Mehmet Sarikaya led efforts in establishing a large Molecular Biomemetics program, an NSF Materials Research Science and Engineering Center (2005-2013), that focused on biological hard tissues and how proteins control inorganic materials assembly, morphogenesis and formation through molecular recognition and specific binding. Based on lessons from biology, a novel approach was developed by which engineered polypeptides could be selected through display protocols and modified utilizing molecular biology techniques and used as molecular building blocks in controlled assembly and formation of functional inorganic and hybrid materials and systems in nano-and nanobio-technology. Inorganic binding polypeptides could be further genetically engineered (e.g., using site directed mutagenesis) to tailor their properties for specific applications. Rules of binding characteristics to inorganics (metals, oxides, and semiconductors) were achieved. Participants included scientists and engineers from Materials Science, Chemistry, Chemical Engineering, Physics, Microbiology at the UW and also from six external Universities in the US and abroad.

Prof. Krishnan developed a program in Spin electronics and Magnetism at the Nanoscale. The broad scope of this research was and remains the systematic exploration and design of fundamental magnetic properties, phenomena and spin-dependent transport of materials as a function of size and dimensionality. New materials structures, the correlation of materials behavior with microstructure (as a function of processing) and applications in emerging technologies were emphasized. All the projects were vertically integrated from the underlying science to their engineering applications. In addition instrumentation and methods to characterize materials by imaging, scattering/diffraction and spectroscopy at the nanometer length scale were a focus of the work. Prof. Krishnan was a co-PI in a National Institue of Health (NIH) RO1 grant with Professor Conolly (UC Berkeley) on Magnetic Particle Imaging (MPI).

Professor Kalonji was the leader in the development of international education and research programs including working as the Director of UW Worldwide since 2000. UWW launched a variety of experiments in multinational project-based education across the disciplines, and was successful in garnering significant levels of external support and recognition. The primary strategy of UW Worldwide was to work with selected partner universities to transform education through collaboration in faculty-student teams on concrete multi-disciplinary research challenges. Collaborations were developed with the UW-Tohoku University Joint Program on Engineering Design, and with the UW-Sichuan University Joint Program focused on Challenges to the Environment in the US Pacific Northwest and southwest China. UW Worldwide efforts brought together faculty from a wide variety of UW colleges and departments, including Engineering, Arts and Sciences, Education, Law, Social Work, Ocean and Fisheries Sciences and Forest Resources. The program expanded efforts to develop new models for internationalizing graduate education, through an NSF IGERT “Multinational Collaborations on Challenges to the Environment”.

Professor Ohuchi led the UW effort in the Development of a UW-PNNL Collaborative Curriculum in Nano-Science and Technology. The overall goal of this project was to develop a prototype for a new method of collaborative education that could meet broad and expanding needs in the areas of nanoscience and nanotechnology. An objective was to speed undergraduate and graduate entry into the nanotechnology field and enhance education and research by developing a new series of four nanoscience and engineering courses in collaboration with Pacific Northwest National

Laboratories. The impact of the course development work extended to many Universities across many states nationwide.

Professor Zhang led several interdisciplinary teams of engineers and clinicians in 6 NIH R01s and 1 NIH N01 projects in areas of BioMEMS, biocompatibility, protein & cell micropatterning, tissue engineering, protein immobilization, and drug delivery & diagnostics. She was the PI for the NIH T32 program: Nanotechnology and Physical Science Training Program in Cancer Research which involves 35 faculty members as mentors from the COE, College of Arts & Sciences, and the School of Medicine at the UW, the Fred Hutchinson Cancer Research Center, Harborview Medical Center, and Seattle Children's Hospital.

Distinguished Alumni

As discussed previously, during the decade of the 1990s and beyond there were a number of distinguished alumni that were being recognized by the MSE Department. Additional awardees are listed here.

Alan G. Miller (1971 BS MetE, 1977 PhD MetE) was the Director of Boeing's 787 Technology Integration. He has served in many leadership roles at the Boeing company and has been heavily involved in professional society leadership roles. At the University of Washington, Dr. Miller was on the Executive Board of the FAA Center of Excellence (Advanced Materials for Transport Aircraft Structures) and played a key role in promoting the MSE department.

Robert Davis (MS MSE '64), became Vice President of Engineering for all Boeing commercial airplane products in 1991 and participated in the design and development of both the 777 and 737 next generation programs. In 1994 he became Corporate Vice President of Engineering and Technology for the entire Boeing Company, the position he held until he retired from Boeing in March 1999. He received numerous professional awards over his career and was a member of the UW College of Engineering Campaign Executive Committee which is leading Engineering's fundraising effort within the university's Campaign UW – Creating Futures.

Rod Boyer (MS MetE '73, BS MetE '63) is a world authority on Titanium metallurgy, who spent his career at the Boeing Company. He was responsible for all of the titanium processing and procurement specifications at Boeing and he directed the industrial effort on titanium alloy development for the NASA-sponsored High Speed Civil Transport Program. He has served as a consultant to Boeing's B-2 and YF22 ATF military airplane programs. He also served as a member of the national panel of experts who provided guidance to NASA and the U.S. Air Force in solving titanium problems on the space shuttle and the B-2 aircraft, respectively.

Mansour Moinpour (MS MetE ’81, PhD MetE ’87) was the Principal Engineer and Materials Engineering Manager at Intel’s Fab Materials Organization. He has authored and/or co-authored over 160 technical papers. He holds numerous patents and is a member of the Materials Science & Engineering Department’s External Advisory Board.

Larry Walters (BS MetE ’72) was a founding member of Taggart Global LLC, a company that designed, built and operated state-of-the-art coal preparation plants and material handling systems worldwide with over $400,000,000 in operating revenue. Mr.Walters served as chair of the American Institute of Mining, Metallurgical and Petroleum Engineers (SME-AIME), and also served on many company boards and health related organizations.

Larry McKnight (BS 1960 MetE) spent over 50 years building an outstanding and distinguished career in the field of metallurgy as a consulting metallurgical and corrosion engineer. He eventually went on to own three companies: Mettek Laboratories (1979-1986), LM Laboratories (1986-1993) and McKnight Laboratory, which he founded in 1993. His contributions to the Department include serving on the MSE Industrial Advisory Board under former MSE Chair Thomas Stoebe and serving on the committee for the Materials Science and Engineering Initiative that raised $2.5 million for the equipping of the undergraduate laboratories in Mueller Hall, and for student and faculty support.

Hira Fotedar (MS 1968, MetE, PhD 1971, MetE) was the President of Fotedar Associates and former Vice President, Quality and Operational Excellence, for Eaton Corporation. He received international awards for his work and in 2009, when the MSE Department set out to raise funds for an endowed fellowship in the name of Prof. Tom Stoebe, Dr. Fotedar was the alumni leader of that campaign and helped us raised over $100,000 for the Stoebe Fellowship. He is also in the process of establishing his own endowment for fellowships with a goal of $100,000.

Facilities and Funding

During this time there were changes in the national funding priorities. Some of these changes were an increased level of support for research teams at the expense of individual research programs; increased emphasis on integration of research and education in all programs; and increased emphasis on research relevant to the national industrial base. Our faculty was able to successfully respond to these trends because of its established strong, passionate interest in teaching, ability to conduct research in groups and the flexibility to work with industry and national laboratories.

Almost the entire total annual expenditures of the MSE department were divided from among three sources: state funds, federal and industrial research grants and contracts, gifts and endowments. Funding sources for the large research programs listed above were from many sources. The total amount of funding raised for the STC was more than 50 million dollars for the University. Biomemetics programs were funded by the DoD, including the Army Research Office and the AFOSR to a level more than $5M for research and equipment. The NIH funded many materials science projects focused on cancer treatment, diagnostics, the microscale Life Sciences Center

(Zhang, Xu, Krishnan, Jen). Additionally, there were many NSF-funded faculty research projects, both with groups and with individual PIs. The State of Washington and the University of Washington also funded projects.

State Resources for the Department teaching and learning and for staff support suffered during the 2000s. Along with the great recession there were enormous cuts in the State budget for the University of Washington. In the early part of the decade the total MSE budget increased but the percentage of the budget funded by the state had begun to decrease. By the end of the decade the state sponsored part of the budget was down to 20 percent. This caused the Department to develop an innovative approach to budgeting, particularly since there was a simultaneous demand for more (undergraduate) student degrees to be awarded.

The bottleneck of UG student enrollment in MSE was exacerbated by the capacity of the lab facilities for many years. To improve the situation, the department initiated several fundraising campaigns to improve the UG lab facilities. In 2006, the department adopted LabVIEW interfacing technology into the Junior Lab after receiving a $50,000 Intel Higher Education Grant. These workstations served for LabVIEW training conducted as part of the labs during the full school year. By 2010, the department has submitted proposals to the UW Student Technology Fund (STF), and had reached $84K at this time for the acquisition Optical Microscopy, UV-Vis Spectrophotometer and an Ellipsometer.

The Decade 2010 - 2019

Materials science is at the center of all engineering fields from bioengineering to computer and electrical engineering, to mechanical and aeronautical engineering. These disciplines all rely on fundamental scientific concepts and advanced materials for further innovation in their specialized fields and for emerging technologies.

As Earth's raw materials dwindle, and there are more environmental concerns for resource management and sustainability, it is becoming clearer that new materials for infrastructure and technological development have to be developed along with materials and systems for clean energy production, storage and distribution. In accordance with the developments of these concepts, there was also the recognition that materials could be developed via bio-inspired approaches and new materials and systems as well as fundamental concepts that describe materials behavior in the synthetic world may actually be also used in all fields of medicine.

By 2010, MSE was entering a new age: controlling matter and energy at the electronic, atomic and molecular levels. Observational science was giving birth to a new paradigm in directing the placement of atoms and the flow of energy to initiate and control chemical and physical phenomena in materials. It was often the case that advanced theory and computational models could predict the behavior of hypothetical materials that could then be constructed in the lab. Once made, these material behaviors could be observed at the electronic and atomic levels and their structures fine-tuned to optimize properties. New opportunities were emerging that could transform the way we live in the future and in which materials are occupying the central role. Based on the progress made during the last two decades, the future of MSE was poised to follow the key areas: clean energy materials and engineering; materials for maintaining and renewal of the infrastructure and technology: biomimetics; biological and medical materials science and engineering; and environmentally-benign mining, manufacturing, and materials development.

Along with the development of new concepts and capabilities, transformational changes were coming in the availability of knowledge and data at our fingertips. Accelerated by the ascent of the internet, novel methods of teaching, learning and even funding were emerging, such as crowdsourcing, cohort teaching, and online classes. In the not so distant future, the challenges facing society that are to be tackled by MSE graduates will need novel curricula that includes experiential learning, project management and entrepreneurship, as well as acquiring essential fundamental science and advanced engineering knowledge. Significant innovation will emerge at the intersection of fundamental science with the discovery of advanced materials and devices, and there is clear advantage of focusing on curriculum and research efforts at this intersection. The challenge for MSE is that it must participate/lead UW's efforts in the continuing national and international competition for discoveries of future materials and systems, using the most advanced facilities and instrumentation, while providing an exceptionally well-trained work-force at all levels of expertise to face these challenges.

With this setting, departmental research and educational program growth continued into the 2010s as new faculty hires, new collaborations and the permanent change in funding model for Universities and for MSE was being implemented. Over the previous decade, state funding for the University had been slashed enormously. Although there was some relief from the state in allowing institutional control over tuition level, tuition could not make up for the deep cuts. As a result, the

Department has joined with other Departments and with engineering centers in the hiring of joint faculty. In 2011, the MSE Applied Masters Program (AMP) was initiated and enrolled the first cohort of students in 2012.

Students

The number of undergraduate and graduate degrees awarded in MSE for each of the years 2010-2019 is given in the table below. In 2013, our undergraduate enrollment increased to nearly 140 from less than 100 per year. This was due to changes in the curriculum and with the improvement of facilities that are discussed below.

Year	BS	MS	PhD	AMP Enrollment
2010	30	3	9	--
2011	32	12	8	--
2012	33	21	13	8
2013	52	28	7	19
2014	57	29	10	31
2015	58	29	8	43
2016	49	41	12	53
2017	52	37	3	70
2018	47	35	8	88
2019	58	44	9	100

The number of students enrolled in the Applied Master's program is also presented in the table above. The Applied Master's program provides an educational pathway for students seeking more in-depth, specialized knowledge in an area of their technical interest, or wish to expand on their research for career advancement. The program has also proven to be a good segue for those looking to pursue a PhD degree. Many have gone this route within our department. AMP students often come from industry or from the MSE undergraduate program, providing a pathway to graduate education in a more applied context. Most students complete a project, research or internship-based paper upon graduation, though thesis options are also available. The program continues to evolve and has been very successful starting with 8 students in 2012 to reaching 100 students in 2019.

In 2018, the College of Engineering implemented a new admissions model. High school Seniors now directly apply for admission to the College of Engineering and those accepted become Direct-to-College (DTC) students and are called Engineering Undeclared students (ENGRUD). Students accepted into the College of Engineering are guaranteed placement into an engineering program if they complete a prescribed curriculum at a set minimum academic standard. Previously, students applied to the University and then after one or two years would apply to different engineering programs. The DTC placement model will require MSE to expand its outreach activities in the future since MSE is an often less known discipline to high school students and early college students compared to other engineering disciplines.

In 2016 the department launched a new initiative - MSE Industry Day, motivated by our goal of fostering strong relationships among our students, faculty, alumni, and industry partners. This event showcases our graduate students' cutting-edge research for colleagues, faculty, and representatives from industry. Prospective employers can also interact with our undergraduate and

graduate students and discuss internship and job opportunities. Industry leaders who have been invited as keynote speakers include Tim Hendry, Vice President of Intel (retired) in 2016, Dr. Tia Benson Tolle, Director of Advanced Materials at Boeing Commercial Airplanes in 2017, Dr. Linda Cadwell Stancin, Director of Research at Lockheed Martin in 2018, and Tim McGuire, Senior Manager of HV Battery Research at Mercedes-Benz Research and Development North America in 2019. The oral and poster presentations at the symposium cover clean energy generation and storage, biomaterials, semiconductors, composites and more. MSE Industry Day helps the department to nurture many existing relationships, and also establish new collaborative partnerships, in an effort to promote the commercialization and licensing of materials discoveries, support applications for external funding, and broaden career prospects for our graduates. It inspires new thinking and discussions that will drive innovation in materials research and engineering over the next decades.

MSE Industry Day

After receiving degrees, our students have been successful in finding meaningful career opportunities. Our undergraduate students have found employment in a number of different industries, positions in government and many continue their education as graduate students. In addition, between 2003 to 2015, 42 of our graduate Ph.D. students have taken jobs in industry primarily with Boeing and Intel but also many other well-known companies such as Micron, DuPont, Maxim Integrated Technologies, Aerojet Rocketdyne, Nth Degree Technologies Worldwide, Inc., Microsoft, EnerG2 and others. Another 10 of these Ph.Ds have become professors and 5 have become lecturers. 11 have taken jobs at National Labs and 18 went on to become postdocs at very prestigious institutions. 2 others have founded companies and 12 have taken jobs in IP industries or in other fields.

Faculty and Administration

There were seven new tenure-track faculty members who joined the Department during this time, in addition to five senior research faculty. The faculty hires represent a diverse portfolio of materials disciplines and activities.

In 2010 Dr. Xiaodong Xu (Ph.D. Physics, Michigan, 2008) was hired to the MSE Department as a joint appointment with Physics. His expertise is understanding the optical, electronic, and quantum properties of novel solid-state nanostructures by nanoscale device design, optical spectroscopy, electrical transport, and scanning photocurrent measurements. Professor Xu has been very successful in his career, having won NSF, DoE and DARPA Young Faculty/Career awards. He also has many other awards for research and innovation, including the COE's most prestigious Faculty Research award, and the AAAFM-Heegar Award in 2019.

Also, in 2010 Dr. Peter Pauzauskie (Ph.D. Chemistry, UC Berkeley, 2007) was hired, with expertise in phenomena at the nanoscale in applications of optical/electronic and mechanical systems. He and his group have demonstrated the first experimental laser cooling of condensed liquids, including liquid water and physiological buffers. Professor Pauzauskie has received the prestigious Air Force Office of Scientific Research Young Investigator Award in 2012.

In 2011 Dr. Jihui Yang (Ph.D. Physics, Michigan, 2000) was hired to MSE from the General Motors Research and Development Center after having been Lab Group Manager & Technical Fellow in the Electrochemistry and Battery System Group at the Electrochemical Energy Research Lab there over a period of 15 years. Professor Yang was appointed as Kyocera Professor and his research experience in batteries supports the Departments energy materials focus. In 2017 he took over the leadership of the Department as the Chair.

In December of 2013, Professor Dwayne Arola (Ph.D., Washington, Mechanical Engineering, 1996) was hired from U. Maryland, Baltimore County (UMBC). Professor Arola has made substantial contributions to the field of restorative dentistry and addressing the impact of aging. He conducts research on the development of structure-property relationships for hard tissues and natural and engineered structural materials for many applications, including body armor.

In 2014 Professor Bruce Hinds (Ph.D. Inorganic Chemistry, Northwestern U., 1996) was hired As the Campbell Professor from the University of Kentucky. Professor Hinds has demonstrated pioneering work in active membrane platforms for a broad spectrum of applications. His impact has been made in voltage driven membranes that actively pump expensive pharmaceuticals and act as biochemical platforms.

In 2015 Dr. J. Devin MacKenzie (Ph.D., MSE, Florida, 1998) was hired as a joint appointment with Mechanical Engineering, after 15 years of industrial experience where he served as founder and CEO of Imprint Energy Corporation. His expertise includes the processing of solar cells, transistors and other devices. Professor MacKenzie has been appointed Washington Research Foundation Professor of Clean Energy. He also is the Chair of the Power Systems Technical Working Group, NextFlex National Manufacturing Innovation Institute and Director of the Washington Clean Energy Testbeds for Scaleup and Characterization. Professor MacKenzie has received the Global Cleantech 100 Award 2014, the R&D Award from the FlexTech Alliance 2014.

In 2018 Dr. Jun Liu (Ph.D., Washington, MSE 1991) was hired from the Pacific Northwest National Laboratories to be the Campbell Chair and as the Materials Science & Engineering Washington Research Foundation Innovation Chair in Clean Energy. Professor Liu is expert in engineering and health, energy and manufacturing and in ceramic processing and properties. He is the Director of the Innovation Center for the Battery500 Consortium, a multi-institute program supported by the U.S. Department of Energy (DOE) with the goal of developing next generation batteries.

Finally, in the fall of 2019, several additional new faculty will be joining the MSE Department as tenure-track assistant professors. Dr. Ting Cao (Ph.D. Stanford 2017) is a computational materials scientist, University of British Columbia Professor Navid Zobeiry is an expert in composites, and Dr. Eleftheria Roumeli (Ph.D. Aristotle University of Thessaloniki, 2014) specializes in the design, fabrication and characterization of natural and synthetic polymer nanocomposite materials. In addition, Dr. Matthew Yankowitz (Ph.D., Columbia, 2015) and Dr. Arthur W. Barnard (Ph. D. Cornell, 2015) are joint Physics-MSE hires who will be joining the UW as tenure-track assistant professors in September 2019 and January 2020, respectively. Professor Yankowitz specializes in investigating and engineering novel physical phenomena in two-dimensional van der Waals materials, and Professor Barnard is an expert on nanoscale mechanics and mesoscopic transport.
MSE Departmental turnover in the 2000s included a number of retirements and resignations. Professor Jen resigned his position in 2016 to become the Provost and Vice President at the City University of Hong Kong and the Chair Professor of Chemistry and Materials Science.

Professor Rao retired in 2012 as Professor Emeritus after having built the Department's reputation for excellence in thermodynamics.

Professor Bordia retired in 2013 to become Professor and Chair of the Materials Science and Engineering Department at Clemson University.

Professor Rolandi resigned in 2015 to become Professor of Electrical and Computer Engineering at the UC Santa Cruz. Professor Flinn, who had a large group and was the advisor for the student SAMPE organization, became a principal partner at GT Engineering in 2016 and is an UW Emeritus faculty member who is still advising our SAMPE chapter.

After the departure of Department Chair Professor Jen, Associate Chair and Professor Fumio Ohuchi became the interim Department Chair for one year. He was followed by Professor Yang who assumed the role of Chair in 2017 having been selected after a full national search was carried out by the College of Engineering.

Professor Yang's vision for the Department includes (1) building consensus, and providing opportunities and inspiration to all faculty, staff, and students to contribute to the future of the department, (2) continuing to provide leadership in nano-, bio-, and energy materials, (3) significantly growing the department by growth in computational materials science, and by providing leadership in materials manufacturing to meet the new national challenges in the United

States, and (4) establishing strong partnership with industry in the local community and across the country.

Research

The fields of materials research in which MSE faculty are involved may be categorized as energy and environmental, computation and theory, structural and, finally, biological/medical materials science and engineering. Faculty have been very productive as reflected by a number of measures. For example, in this decade four MSE faculty members (Cao - Materials Science; Jen - Materials Science; Liu - Materials Science, Chemistry; and Zhang - Pharmacology & Toxicology) were named as the *Highly Cited Researchers* (http://highlycited.com/) by Thomson Reuters. Professor Luscombe's research work was selected as the Editorial Board top 10 picks by the Polymer Chemistry Journal. Over ten years, our faculty have published in the highest impact journals such as Nature and in the family of Nature journals, Science, Advanced Materials, Physical Review Letters, Journal of Fluid Mechanics, Nature of Materials, PNAS, Advanced Materials and ACS journals. Many of our faculty have very high citation indices, an indication of global leadership in their respective fields. Our faculty scholarship has also been illustrated in published monographs and text books. Professor Cao co-authored two books on nanotechnology, "Nanostructures and Nanomaterials: Synthesis, Properties and Applications" (2nd edition, World Scientific Publisher Co., Singapore, January 2011) and "Environmental Applications of Nanomaterials: Synthesis, Sorbents and Sensors" (2nd edition, Imperial College Press, London, UK, 2012). The first one has been translated into Chinese and Russian. Professor Krishnan published a text book on magnetism, "Fundamentals and Applications of Magnetic Materials" (1st Edition, Oxford University Press, Oxford, UK, 2016).

Research publications are only one metric by which our faculty may be measured. However, the impact of the faculty has been multi-faceted. Many MSE faculty are entrepreneurial and have created start-up companies. Examples are Soluxra, LLC and Advanced Electroluminescence Systems (Jen), LodeSpin Labs (Krishnan), Essential Biomatrix Inc. and Globe Preventive and Pharmaceutical Medicine, Inc., (Zhang), KitoTech Medical (Rolandi), Seattle Biomimetics Sciences Inc. (Sarikaya). Four start-up companies: EnerG2 (supercapacitors and ultracapacitors), LivinGreen Materials (solar cells), Lumis silicon (quantum dot phosphors), and C&C Materia (rechargeable batteries) have been motivated by work carried out in Professor Cao's lab. These are all examples of the economic impact of our faculty benefitting the state of Washington and the nation.

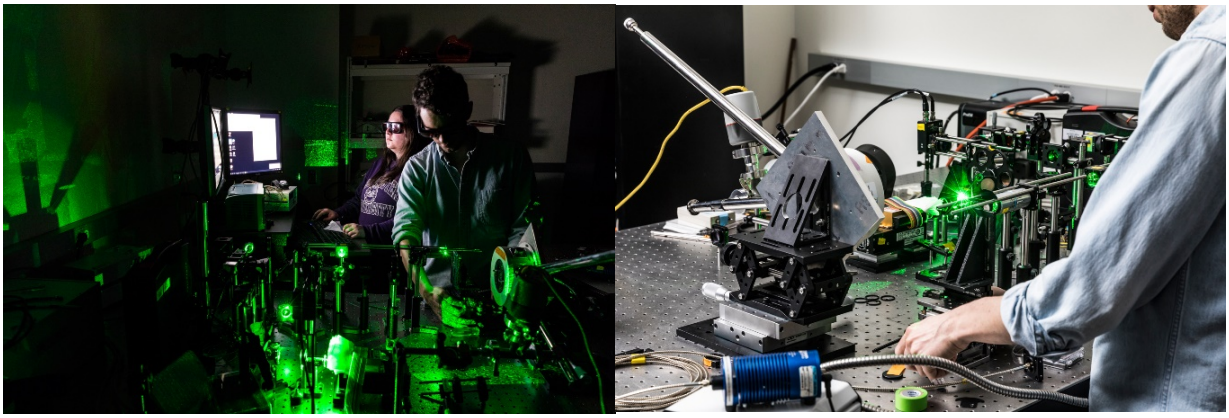
There also have been a very large number of patents awarded to our faculty. Professor Jen and his group had over 25 patents. Prof. Ma and his co-inventors have been awarded 6 patents related to self-assembled monolayers, interfacial materials for solar cells and organic/polymer nonlinear optical materials. Professor Krishnan has developed media architecture for Bit Patterned Media involving information storage and the design of logic gates for Magnetic Quantum Cellular Automata. Professor Yang holds 18 US patents (before he joined UW) on sensors used in automotive engine control; on thermoelectric technology for automotive waste heat recovery, on high capacity battery electrode materials, and on thermal management of Li-ion batteries. He developed an automotive waste heat recovery system, which was highlighted by many news agencies. Professor Zhang has contributed to the development of biomaterials for clinical use. Her group has been issued 20+ patents to date. Professor Cao has been granted 14 US patents and was

named the Presidential Entrepreneurial Faculty Fellow in 2012. Professor Hinds has been awarded two patents related to carbon nanotube membranes for drug delivery devices and active chemical separations. Professor Sarikaya has been awarded 5 patents and has other IP developments focusing on dental materials and therapies and other health and technology fields. Professor Pauzauskie is developing engineered optoelectronic nanomaterials for photothermal theranostics and so far, this has led to 4 issued patents. Professor MacKenzie has 23 issued patents to date on optoelectronic materials, devices, and applications.

Large Scale Collaborative efforts

Pooling talents, expertise and interests, MSE faculty and colleagues have continued to focus in key research areas. In energy, scalable and printable photovoltaic devices, ultrafast and low energy consumption information technology (*Internet of Things*), printable/wearable electronics, energy storage materials and devices, are some of the focus areas. In biomimetics, biomaterials, and materials in medicine, focus areas include cell-based tissue engineering and scaffold design, cell-free tissue engineering via biomineralization, biosensors, drug delivery and control release systems, biomonitoring, implant biofunctionalization, dental materials and procedures, and biomimetic photosynthesis. In infrastructure and manufacturing, embedded smart sensors and systems, additive manufacturing and printable manufacturing are areas of focus. The best way to jump start these activities and acquire leadership roles is through the formation of major collaborative and interdisciplinary projects such as MURIs, federal-funded Centers, and Institutes. MSE has pursued many such large projects through a variety of pathways involving federal funding and institutional programs, each relevant to our expertise, strength, and leadership.

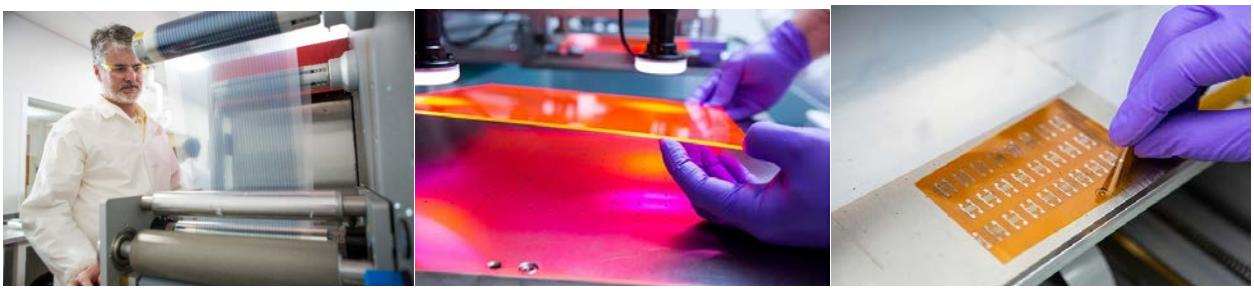
In the past ten years, the MSE faculty has worked as a small but dynamic unit with campus-wide units (COE, A&S, Radiology, Medical and Dental Schools, Fred Hutchison Cancer Research Center), companies (Intel, Boeing, HP, Microns, Microsoft, EnerG2), and the PNNL National Laboratory to conduct very exciting interdisciplinary research and education in critical areas of materials science & technology development. The MSE faculty and students have led or participated in the establishment of several high profile centers (NSF-Materials Research Science & Engineering Center, NSF- Materials Genome Initiative, NIH-Center of Excellence for Genome Sciences, TR-32 training grant, DARPA Molecular Photonics) and research institutes (Institute of Advanced Materials for Energy, Institute of Molecular Engineering Science, and the Clean Energy Institute) which have generated enormous impact on campus-wide research and education. These efforts have resulted in high-tech developments in fields of telecommunications, nanomedicine, bionanotechnology, renewable energy, aerospace, and dental treatment.



Abbie Ganas and Matthew Crane from the Pauzauskie group operate equipment that employs a laser to heat the gasket of a high-pressure diamond anvil cell above 3,100 F, more than one-third the temperature of the sun.

Specific examples of large collaborative programs involving MSE leadership include the Molecular Engineering Materials Center (MEMC) which is an NSF funded Materials Research Science and Engineering Center (Director: Prof. Gamelin, Chemistry). MSE Professor Xu is the Layered Quantum Materials Interdisciplinary Research Group (IRG) Leader of the MEMC which is one of two IRGs in the center. Professor Luscombe is the Executive Director of Education and Outreach of the MEMC. Professors Pauzauskie, Yang and DeYoreo are faculty members in the MEMC. Professor Xu is also the PI of an Air Force Office of Scientific Research - Multidisciplinary University Research Initiative (MURI) involving MIT, Cornell, Carnegie Mellon and the Ohio State University. The MURI is entitled MAGIC: New Science from Two-Dimensional MAGnetIC Heterostructures and it is focused on 2D Magnetic Heterostructures for Flexible, Lightweight 2D Electronics. Professor Arola is the PI of a multi-department $1 million National Science Foundation Scholarship in Science, Technology, Engineering, and Mathematics grant to attract and retain more students from groups underrepresented in engineering. The US Department of Energy funds the Center for the Science of Synthesis Across Scales (Director: Baneyx, Chem. Eng) in which Professor DeYoreo is the Deputy Director. Professor Yang is the PI of a NSF Materials Genome Program on developing hierarchical thermoelectric nanocomposites with co-PIs Li (ME) and Jen. Professor Luscombe participated in the NSF-Emerging Frontiers in Research and Innovation on “Towards zero-energy buildings based on electrochromic windows and energy-harvesting” and the NSF-Center for Chemical Innovation on “Center for Selective C-H Functionalization”. Professors Yang and Cao were the co-PIs of a NSF MRI award that included Ginger (Chem), Li (ME), and Overney (ChemE). Professor Xu was the co-PI of another NSF MRI award: “Acquisition of a Nanotopography Capability at the UW Microfabrication Facility” (PI: K. Bohringer in EE). Prof. Pauzauskie and Professor Xu were the co-PIs of a Murdock award: “A Nanomaterials Synthesis and Spectroscopy Laboratory” (PI: Gamelin, Chem). Professors Hinds and Jen were the faculty participants in the National Nanoscale Center Infrastructure (NSF-NNCI) ($7.5M) collaborative grant for the campus nano-fabrication user facility. Washington Research Foundation Innovation Professor of Clean Energy MacKenzie is the Technical Director of the Washington Clean Energy Testbeds. Professor Liu is currently the Director for the Innovation Center for Battery500 Consortium that includes four national labs, five universities, Tesla, IBM and the main automobile industry. The consortium is currently funded by DOE at $50M over five years and is currently the largest funded applied battery program in the United States. Professor Yang and Professor Venkat Subramanian (Chemical Engineering) are both PIs of the the Battery500 Consortium. Professor Sarikaya’s NSF MRSEC: Genetically

Engineered Materials Science and Engineering Center continued into this decade (2005-2013, $7.5M).



Professor MacKenzie working at the CEI Testbests, Clean Energy Institute

Distinguished Alumni

Our alumni have continued to distinguish themselves for their contributions to MSE in industry, laboratory work and in service to the materials science community and to the University of Washington. Our distinguished alumni award list below is continued from those that have been listed in previous decades.

Mohan Misra (MS 1970, MetE) founded ITN Energy Systems, Inc. in 1995 to research, develop and commercialize emerging technologies in the fields of energy, environment and space. Dr. Misra has successfully established four commercial ventures based on the technologies developed at ITN Energy Systems, Inc, Global Solar to manufacture thin film photovoltaics; Infinite Power Solutions for solid state thin film batteries; MicroSat Systems, Inc. to design and build small satellites and Ascent Solar Technologies. Dr. Misra was a member of the UW MSE External Advisory Board.

Steven Ching (BS 1972, CerE) started his career in electronics with Fairchild Semiconductors Linear Integrated Circuits Division. From there he moved on to Hewlett Packard's Opto-electronics Division and then to General Instruments' Optoelectronics Division. In 1987, Mr. Ching was a co-founder of Isolink Inc., where he served as President until 2013. Isolink was the leading supplier of high performance and high-quality optoelectronic radiation tolerant components worldwide.

Hayden Thomas (BS 1982, CerE) served as the Chair of our department's External Advisory Board, on which he has been an active member since 2007. Prior to this, Hayden served on the College of Engineering's Visiting Committee as the representative from Intel Corporation. Hayden spent 24 years at the Intel Corporation where he held various engineering, operations and general management positions in the Corporate Technology & Manufacturing Group, the Intel New Business Group and several IA Product groups. Mr. Thomas's last position at Intel was the Director of Operations for the Digital Enterprise Group (DEG) and a joint appointment as the Director of Intel's Corporate Platform Office. Hayden was also a Senior Vice President of LSI Corporation. He also held several senior executive positions including oversight

for Worldwide Operations, Business and Product Operations, Human Resources, Corporate Communications and Philanthropy.

Peter Herley (BS 1987, MetE) was a Technical Fellow in the Boeing Research & Technology Mechanical Parts Engineering Group, which specializes in the development, qualification, and specification of mechanical fasteners, bearings, and miscellaneous hardware manufactured from a variety of aerospace materials and product forms. In this role, Pete was a senior lead engineer. Mr. Herley has collaborated with the University of Washington, first as an instructor and now as the Boeing coordinator for MSE 310 “Introduction to Materials Science.”

John Smythe (BS, CerE 1980, PhD MSE, 2009) has been with Micron since 2002, is an author of over 50 issued US Patents and several publications in the field of materials and semiconductor processing methods. He currently serves on the MSE Departmental Advisory Committee.

Kevin Lewis (BS, Metallurgy) is presently Vice President of Fire Forensics at Jensen Hughes, the nation's leader in investigations involving complex and large fires and explosions, which typically result in millions of dollars in damage. His failure analysis casework includes corrosion analysis, metallography, and physical property testing on a wide variety of materials such as metals, plastics, polymers, composites and ceramics. Over the past several years, Mr. Lewis has served as a volunteer lecturer within MSE, delivering seminars for both MSE 431 (Failure Analysis) and MSE 498 (Entrepreneurship).

Donald Gorski (BS CerE 1978) is a retired executive with 20+ years of demonstrated business success in retail, industrial and consumer product companies that range in size from start-up to $1 billion of revenues. During his career, he had the privilege and experience to be assigned to most of the major executive positions (CEO, COO and CFO). Mr. Gorski currently serves on the Board of Directors for two different private companies and volunteers at various non-profit organizations such as the MSE department of the University of Washington.

Aaron Feaver (PhD MSE 2006) is now working in the public research sector in the State of Washington, after two successful clean tech startups in the battery materials space - EnerG2 and Group14. As Director of The Joint Center for Deployment and Research in Earth Abundant Materials (JCDREAM) administered through WSU, he aims to bring together researchers at WSU, UW, PNNL, and other Washington State institutions to focus on the following vision: Washington State will become a leader in solving the problems of inordinate environmental and human rights impact stemming from 1st world consumption of critical or rare-earth materials. Prior to JCDREAM he co-founded EnerG2 and Group14 and have written and spoken extensively on nanotechnology topics. Dr. Feaver led EnerG2's technology development from inception at the labs of the University of Washington in 2003 to a venture-backed business, and eventually to our acquisition by BASF - the world’s largest chemical company. As a founder of Group14 which develops silicon-carbon composite materials for lithium ion anode materials, he continues to be intimately involved as a close advisor.

Randy Kurosky (BS CerE ’88)
As the co-inventor of two ceramic oxide powder processes and engineer of over 3,000 different metallic oxide compositions, Randy Kurosky turned Seattle Specialty Ceramics, a technology transfer startup, into Praxair Specialty Ceramics, one of the premier electronic grade specialty ceramics companies. As an undergraduate, Randy co-invented a patented process, combustion spray pyrolysis, that earned him six publication co-authorships. His innovations on the synthesis of solid oxide fuel cell materials have become the industry standard.

Funding and Facilities

Departmental income during the decade has been generated by grants and contracts, GOF, gifts and discretionary funding, indirect cost returns from grants and contracts, the Applied Master’s Program, student technology fees and user facilities. The largest source of funds are grant expenditures, typically close to 2/3 of the MSE source of funding, and GOF which is nearly 1/4 of the funding. The GOF funding is used for faculty instruction, academic advisor administration and graduate student salaries and benefits. The AMP program has undergone significant growth during the decade and has been a valuable new source of Departmental funding.

MSE’s strong record for involvement in at least eight large center activities in the past 10-15 years have totaled over $130M to the university community. Direct benefits to the department have included high visibility in the area of energy and biomaterials, 15,000 sq. feet of new space in Bagley Hall, in Physics, the Molecular Engineering and Science program, Benjamin Hall and the new Nano building. The Clean Energy Institute (CEI) was directly involved with the start-up of 2 faculty hires (MacKenzie, Liu). Through CEI an $8M investment in roll-to-roll processing and test-beds for battery and solar cells was made, with MSE faculty (Yang, MacKenzie) providing key technical leadership in both material systems and processing methods.

Two of our current ten endowments are the result of generous gifts given by current and former faculty members. Five endowments were made possible by gifts from loyal alumni. To recognize and honor the legacy of a late family member who earned a degree from the department, the families of two alumni have created endowments in the name of their loved ones. Finally, a tenth endowment was created by a much beloved professor emeritus. Several alumni generously support this fund in celebration of the outstanding teaching and mentoring provided during the more than 40-year tenure of this professor.

In 2019 the Materials Science and Engineering (MSE) Department at the University of Washington (UW) is poised to celebrate its 125th anniversary. This provides us with a historic moment to reflect on the tremendous achievements of our alumni and faculty. Graduates of UW MSE include one of the most experienced female astronauts in the world, inventors of ultrapure high-surface area carbon, influential business leaders, successful entrepreneurs, members of National Academies, and accomplished academicians of all time. Our faculty have also demonstrated incredible economic and scientific impact through dedicated teaching and research in the past 125 years. The department started as the School of Mining Engineering in 1983-1984, and became a nationally recognized educational and research institute for mining and minerals in the early 1900s. In the late 1900s our faculty were widely honored for the invention and development of ceramic

tile thermal insulations on NASA's space shuttles. Over time the educational and research focus has been expending from metallurgy, ceramics, composites, and electronic materials; to functional materials, nanotechnology, molecular biomimetics, biomedicine, and energy and sustainability. As we look forward to building the future of MSE, the department will continue to strive for addressing significant problems that our society needs and will be facing in the future, as well as educating students in a wide spectrum of areas from fundamentals to engineering of traditional and advanced materials.

UW Materials Science & Engineering Labs 2019

APPENDIX I

Biographical Data on Significant Members of the Faculty.

Ilhan A. Aksay B.S., 1967, Ceramic Engineering, University of Washington; M.S., 1969, Ph.D., 1973, University of California at Berkeley. Associate Professor of Materials Science Engineering at the University of Washington, 1983; Professor, 1985. Resigned from the faculty in 1992 to join the faculty at Princeton University.

Donald L. Anderson B.Sc., 1938, St. Francis Xavier University of Nova Scotia; B.S., Mining Engineering, 1941, University of Illinois. Instructor of Mining Engineering at U.W., 1947; Took leave in 1949, returned in 1953; Professor, 1964; Acting Chairman, 1968-1969; Professor of Mining and Adjunct Professor of Geological Sciences, 1975. After retiring in 1982 as Professor Emeritus, lived in Arizona and continued to consult on mine development. Passed away in 1990.

Thomas F. Archbold B.S., 1955, M.S., 1957; Ph.D., 1961, Metallurgical Engineering, Purdue University. Assistant Professor of Metallurgical Engineering at U.W., 1961; Associate Professor, 1968, Professor of Mining, Metallurgical, and Ceramic Engineering, 1973. Retired as Professor Emeritus, 1997. He passed away in 2007.

Dwayne D. Arola B.S., 1989, M.S., 1991, Ph.D., 1996, Mechanical Engineering, University of Washington. Assistant Professor of Mechanical Engineering at the University of Maryland Baltimore County 1997, Associate Professor, 2003-2008; Associate Professor of Materials Science and Engineering at the University of Washington, 2014-present. NSF Career Award 2003; Fulbright Fellow 2016. Currently on faculty.

Arthur W. Barnard B.S., 2008, Engineering Physics; Ph.D., 2015, Applied Physics, Cornell University. Nano- and Quantum Science and Engineering Postdoctoral Fellow, 2014-2018, Stanford University. Assistant Professor of Materials Science and Engineering and Physics, 2019-present. Currently on faculty.

Rajendra K. Bordia B. Tech., 1979, Mechanical Engineering, Indian Institute of Technology; M.S., 1981, Materials Science & Engineering, Cornell University; Ph.D., 1986, Materials Science & Engineering, Cornell. Research Scientist at E. I. du Pont de Nemours & Company, 1986-91. Associate Professor of Materials Science and Engineering at U.W., 1991. Professor 2003-2013. Chair of Materials Science and Engineering 1998-2005. National Young Investigator Award, 1992-97; Du Pont Young Professor Award 1993-96. Retired 2013 to become Chair of Materials Science and Engineering at Clemson University.

Richard C. Bradt B.S., 1960, Materials Engineering, Massachusetts Institute of Technology; M.S., 1965; Ph.D., 1967, Rensselaer Institute of Technology. Professor and Chairman of the U.W. Department of Materials Science and Engineering at U.W., 1983; First appointee to the Kyocera Distinguished Chair in Ceramic Engineering, 1986. He left the University in 1989 to join the University of Nevada.

Frederick B. Brien B.S., Mineral Engineering, 1950, University of Alberta; M.S., Mineral Engineering, 1951, Columbia University. Assistant Professor of Mineral Engineering at the U.W., 1954; Associate Professor, 1957; Professor of Metallurgical Engineering, 1963. He died in 1975 at the age of 57.

Lucien N. Brush B.E.S., Materials Sciences and Engineering, 1980, The Johns Hopkins University; M.E., 1984, Ph.D., 1988, Metallurgical Engineering and Materials Sciences, Carnegie Mellon University. Assistant Professor of Materials Science and Engineering at U.W., 1990, Associate Professor, 1996. Associate Chairman of MSE Department, 2017 – present. Currently on faculty.

Robert J. Campbell, Jr. B.S., 1939, Oregon State College; M.S., 1954, University of Washington. Acting Assistant Professor of Ceramic Engineering at U.W., 1955; Assistant Professor, 1957; Associate Professor, 1981; Associate Chairman of the Department, 1971-1982. Retired in 1982 as Associate Professor Emeritus. Upon his death in 1992 he contributed his estate, over one million dollars, to establish a Professorship for a person with an industrial background.

Guozhong Cao B.S. , 1982, Materials Science and Engineering, East China University of Science & Technology; M.S., 1985, Materials Science and Engineering, Shanghai Institute of Ceramics; Ph.D., 1991, Materials Science and Engineering, Eindhoven University of Technology, Netherlands. Research Associate, University of Twente, 1991 – 1993: Research Associate, the University of Nijmegen, 1993 – 1995; Senior Research Associate, Sandia National Lab and University of New Mexico, 1995 – 1996. Assistant Professor of Materials Science and Engineering at U.W. 1996; Associate Professor, 2002; Professor, 2007; UW Boeing-Steiner Professor, 2008-present. Thomson Reuters Highly Cited Researcher in Materials Science - 2014, 2015. Currently on the faculty.

Ting Cao B.S., Physics, 2012, Peking University; Ph.D., Physics, 2018, University of California, Berkeley. 2018 – 2019, Postdoctoral Associate, GLAM Fellowship, Stanford University. Affiliate Assistant Professor of Materials Science and Engineering, 2018 - 2019, Assistant Professor of Materials Science and Engineering, University of Washington, 2019 – present. Currently on faculty.

Clarence R. Corey Educated at the Colorado School of Mines and the Montana School of Mines, with two years of technical experience. Instructor in Mining and Metallurgy at the U.W. in 1907. In 1914 left for graduate study at Columbia University, then returned. Retired in 1947 due to illness.

Joseph Daniels S.B., 1905, Massachusetts Institute of Technology; M.S., 1908, Lehigh University, where he held an Associate Professorship. Assistant Professor in Mining and Metallurgy at the U.W., 1911. Retired in 1954 as Professor Emeritus and worked as a consultant in the United States and abroad.

Henk I. Dawson B.S., 1960; M.S., 1962; Ph.D., 1964, Physics, Technical University, Netherlands. Assistant Professor in Metallurgy at the U.W., 1966; Associate Professor, 1969.

Left to study medicine at the University of Miami in 1973 and practiced medicine in Seattle. Passed away in 2017 at age 77.

David B. Fischbach B.A., 1950, Denison University; M.S., 1951; Ph.D., 1955, Yale University. Research Associate Professor of Ceramics at the U.W., 1969; Research Professor of Mining, Metallurgical, and Ceramic Engineering, 1977; Professor of Materials Science and Engineering, 1987. Retired as Professor Emeritus in 1992. Passed away in 2013 at the age of 86.

William F. Flanagan B.S., 1951, M.S., 1955, Mineral Engineering, Massachusetts Institute of Technology. Assistant Professor of Mineral Engineering at the U.W., 1959. Left in 1966 to join the General Motors Research Laboratory, and later the faculty at Vanderbilt University.

Brian Flinn B.Sc., 1984, M.S., 1986, Metallurgical Engineering, Colorado School of Mines; Ph.D., 1991, Materials Engineering, UC Santa-Barbara. Post-doctoral, Materials Science and Engineering, University of Washington, 1991 – 1994. Research Assistant Professor of Materials Science and Engineering, 1995, Research Associate Professor, 2002-2016. Fellow, Society for the Advancement of Materials and Process Engineering (SAMPE) 2017. MSE Research Professor Emeritus in 2016.

Sossina Haile BS., 1986, Materials Science and Engineering, Massachusetts Institute of Technology (MIT); M.S., 1988, Materials Science and Engineering, University of California (Berkeley); Ph.D., 1992, Materials Science and Engineering, MIT. Fulbright Fellow, 1991-92. Assistant Professor of Materials Science and Engineering at U.W., 1993. Resigned from the faculty in 1996 to take a position at the California Institute of Technology.

Bruce J. Hinds III, B.S., 1991, Chemistry, Harvey Mudd College; M.S., 1992, Ph.D., 1996, Chemistry, Northwestern University. Post-doctoral, Physics, North Carolina State University, 1996-1998; JSPS/NSF Research Fellowship, Tokyo Institute of Technology, 1998. Associate Professor of Chemical & Materials Engineering, University of Kentucky, 2001; Professor, 2007. Professor of Materials Science and Engineering, University of Washington, 2014-present. NSF Early Career Award 2004, Presidential Early Career Award 2009. Currently on faculty.

Alex K.-Y. Jen, B.S., 1978, Chemistry, National Tsing Hua University, Taiwan; Ph.D., 1984, Chemistry, University of Pennsylvania. Group Leader/Senior Scientist, EniChem America Inc., 1988-1994; Vice President, ROITech, 1995-1996. Associate Professor, Northeastern University, Boston, MA, 1997-1999; Boeing Johnson Chair Professor of Materials Science and Engineering, University of Washington, 1999-2016; Chair of Materials Science and Engineering 2005-2016. Resigned in 2016 to become Provost and Professor at the City University of Hong Kong.

John H. Jones, B.S., 1964; M.S., 1967; Ph.D., 1969, Colorado School of Mines. Assistant Professor of Metallurgical Engineering at the U.W., 1969; Left in 1976 to work at Boeing. Served as an acting instructor several times, 1982- 90.

Gretchen Kalonji, B.S., 1980, Ph.D., 1982, Materials Science and Engineering, Massachusetts Institute of Technology. Assistant Professor M.I.T., 1982; Associate Professor, 1986. Recipient of Presidential Young Investigator Award, 1984. Kyocera Professor of Materials Science and

Engineering at U.W., 1990. Resigned from the University of Washington in 2005 for positions at the University of California.

Michael J. Kaufman, B.S., 1979; Ph.D., 1984, University of Illinois. Assistant Professor of Materials Science and Engineering at U.W., 1986. Resigned from the faculty in 1988 to join the faculty of the University of Florida. Currently Professor of Metallurgical And Materials Engineering and Vice Provost For Graduate Initiatives And Dean Of Materials And Energy Programs, Colorado School of Mines.

Ryoichi Kikuchi, B.S., 1942; Ph.D., 1951, Tokyo University. Affiliate Professor of Materials Science and Engineering at U.W., 1984; Research Professor, 1985. He left in 1987 for a position on the faculty at UCLA.

Kannan Krishnan B. Tech., 1978, Mechanical Engineering, Indian Institute of Technology, Kanpur; M.S., 1980, Materials Science & Engineering, State University of New York, Stony Brook; Ph.D., 1984, Materials Science & Engineering, University of California, Berkeley. Scientist, Lawrence Berkeley National Laboratory, UC Berkeley, Materials Sciences Division, 1984-2001 and Senior Scientist 1998-2001. Professor of Materials Science and Engineering, University of Washington 2001- present. Alexander von Humboldt Forschungspreis (Career Research Award), Germany, 2016. Fellow of IEEE and the APS. Currently on faculty.

Henry Landes B.A., 1892; M.A., 1893, Harvard. Professor of Geology and Mineralogy at U.W., 1895-1936; Washington State Geologist, 1901-1921; Dean of the U.W. College of Science, 1913-32; Acting President of U.W., 1914-15; U.W. Dean of Semi-Professional Studies, 1934-35; Vice Dean of U.W. University College, 1935-36. Passed away in 1936.

Barry D. Lichter B.S., 1953; M.S., 1955; D.Sc., 1958, Massachusetts Institute of Technology. Associate Professor in Metallurgical Engineering at U.W., 1964. Left in 1968 to accept a faculty position at Vanderbilt University.

Jun Liu B. S., 1982, Chemical Engineering, Hunan University, China; M.S., 1986, Ceramic Engineering, University of Washington; Ph.D., 1990, Materials Science and Engineering, University of Washington. Staff and leadership positions at Pacific Northwest National Laboratory (PNNL) 1993–2001, 2005 – 2013 and at Sandia National Laboratories, 2001-2005. Division Director, Energy Processes and Materials, PNNL, 2013-2019. Washington Research Foundation Innovation Chair in Clean Energy and Campbell Chair of Materials Science & Engineering and Professor of Chemical Engineering, 2018-present. Member of Washington Academy of Science, Fellow of Materials Research Society and American Association for the Advancement of Science. Currently on faculty.

Christine Luscombe B.A., M.Sci, Honors, 2000, M.A. 2003, Natural Sciences, University of Cambridge; Ph.D., 2005, Chemistry, University of Cambridge. Lindemann Fellow 2004 – 2006, Department of Chemistry, UC Berkeley.
Assistant Professor of Materials Science and University of Washington, 2006; Associate Professor 2011; Professor 2017. UW College of Engineering Faculty Award for Research, 2019; Fellow of the Royal Society of Chemistry, 2016. Director of the Molecular Engineering PhD program, 2016-

present. Steering Committee for UW Clean Energy Institute, Committee for UW Molecular Engineering and Science Institute 2012 - present. Currently on faculty.

David C. Lynch B.S., 1971, University of Washington; D.Sc., 1976, Massachusetts Institute of Technology. Assistant Professor of Mining, Metallurgical, and Ceramic Engineering at U.W., 1976; Associate Professor, 1982. Left in 1984 to join the University of Arizona.

Dorsey A. Lyon B.A., Stanford, 1898; Assistant in Mineralogy and Assaying at Stanford, 1897-98. Instructor in Geology and Mining Engineering at U.W., 1898; Assistant Professor in Mining Engineering and Metallurgy, 1899. Left in 1901 to continue his education. Founding faculty member of the Stanford Dept. of Metallurgical Engr. 1919.

J. Devin MacKenzie S.B., 1993, MIT, Materials Science and Engineering; M.S., 1997, Ph.D., 1998, Materials
Science and Engineering, University of Florida; Postdoctoral, 1998-2001, Physics, Cambridge University.
Founder, Plastic-Logic, Ltd., 2001-2003. Chief Executive Officer and Board of Directors, Imprint Energy, 2011-2015. Associate Professor of Materials Science and Engineering and Associate Professor of Mechanical Engineering, Washington Research Foundation Professor of Clean Energy, University of Washington, 2015-Present. Director of the Washington Clean Energy Testbeds for Scaleup and Characterization, 2016-Present. Currently on faculty.

Alan D. Miller B.S., 1957, Ph.D., 1967, Ceramic Engineering, University of Washington. Part-Time Instructor in Ceramic Engineering at U.W., 1957; left in 1958; returned as Assistant Professor in Research, 1967; Associate Professor of Mining, Metallurgical, and Ceramic Engineering, 1975; Director of the U.W. Engineering Advising Center, 1978. Elected Fellow of the American Ceramic Society in 1986. Served as Associate Chairman of the Department until retiring in 1995.

Edward E. Mueller B.S., Ceramic Engineering, 1948, Missouri School of Mines; M.S., 1932; Ph.D., 1953, Ceramic Engineering, Rutgers University. Assistant Professor of Ceramic Engineering at U.W., 1953; Associate Professor, 1956; resigned in 1959; returned as a Visiting Professor, 1981. Retired from the faculty of the New York State College of Ceramics at Alfred University.

James I. Mueller B.S., Ceramic Engineering, 1939, Ohio State University; Ph.D., 1949, Ceramic Engineering, University of Missouri. Joined the faculty of the Ceramic Division of the School of Mineral Engineering at U.W. in 1949; Chairman of Mining, Metallurgical, and Ceramic Engineering, 1970-1973. Elected Fellow of the American Ceramic Society, 1979; National President of the American Ceramic Society, 1981-82. Continued as U.W. Professor of Ceramic Engineering until his passing away from cancer in 1986 at the age of 69.

Fumio Ohuchi, B.S., 1972, M.S., 1974, Physics, Sophia University (Tokyo); Ph.D., Materials Science and Engineering, 1981, University of Florida. Research scientist at E.I. du Pont de Nemours and Company 1981-92. Associate Professor of Materials Science and Engineering, at

U.W. since 1992, Professor, 1996. Associate Chairman, MSE Department 2006 – 2017. Interim MSE Chair 2017. Currently on faculty.

Joseph A. Pask, B.S.,1934, Ceramic Engineering, University of Illinois-Urbana; M.S., Ceramic Engineering, 1935, University of Washington; Ph.D., 1941, Ceramic Engineering, University of Illinois-Urbana. Assistant Professor and Head of Ceramic Engineering Program at U.W., 1941-43. Emeritus Professor of Materials Science and Mineral Engineering at the University of California at Berkeley. He passed away in 2003 at the age of 90.

Peter Pauzauskie, B.S., Mathematics, B.S., Chemistry, B.S., Chemical Engineering, 2002, Kansas State University;
Ph.D., 2007, Physical Chemistry, University of California, Berkeley. Assistant Professor of Materials Science and Engineering, University of Washington, 2010; Associate Professor, 2016. Received the Air Force Office of Scientific Research Young Investigator Award 2012. Currently on faculty.

Thomas P. Pearsall B.E. Thayer School of Engineering, 1968; Dartmouth College; M.S., Solid-State Physics, 1970, University of London; Ph.D., Applied and Engineering Physics, 1973, Cornell University. Research scientist AT&T Bell Laboratories, 1973-76, 1981-89. Research scientist, Thomson/CSF, Orsay, France, 1976-81. Boeing Professor of Semiconductor Electronics at U.W., 1989; Director of the Compound Semiconductor Technology Center, Washington Technology Center, 1989-93; Professor of Electrical Engineering, 1989; Professor of Materials Science and Engineering, U.W., 1992; Adjunct Professor of Physics, since 1992. Resigned from position at UW in 2001 ans is currently a consultant on electronic materials, residing in France.

Drury A. Pifer B.S., 1930, M.S., 1931, Mining Engineering, University of Washington. Associate Professor at U.W., 1945; Succeeded Milnor Roberts as Director of the School of Mineral Engineering, 1947. Retired in 1970 and passed away in 1972.

Douglas H. Polonis B.Sc., 1951, Metallurgical Engineering, University of British Columbia; M.Sc., 1953, Metallurgical Engineering, University of Toronto; Ph.D., 1955, Metallurgy, University of British Columbia. Acting Assistant Professor of Mineral Engineering at U.W., 1955; Professor, 1962; Chairman of the Department of Mining, Metallurgical and Ceramic Engineering,1969-1971 and 1973-1982. Elected Fellow of ASM, 1985. Served as a member of the Engineering Accreditation Commission. Retired as Professor Emeritus in 1996.

Y. Krishna Rao B.S., 1958, Metallurgical Engineering, Andhra Loyola College; M.S., 1962, Metallurgical Engineering, Banaras Hindu University; Ph.D., 1965, Metallurgical Engineering, University of Pennsylvania. Associate Professor of Metallurgical Engineering at U.W., 1976; Professor,1980. The author of the comprehensive text, Stoichiometry and Thermodynamics of Metallurgical Processes. Retired as Professor Emeritus in 2012.

Earl C. Roberts B.S., 1943, Metallurgical Engineering, Montana School of Mines; M.S., 1950; D.S., 1952, Massachusetts Institute of Technology. Associate Professor of Metallurgical

Engineering at U.W., 1954; Professor, 1958. Resigned in 1963 to join the Boeing Company. Returned to U.W. in 1972 for a year as Part-Time Professor. Passed away in 1984.

Milnor Roberts Educated at Hartford, Connecticut, Cutler Academy at Colorado Springs; B.A., 1899, Stanford University, and Instructor for two years while carrying graduate studies in Mining and Geology. Dean of the U.W. School of Mining Engineering and Professor of Mining and Metallurgical Engineering, 1901; Continued as Dean of the College of Mines, 1911. Retired in 1947 after serving the university for 46 years. Passed away in 1965.

Marco Rolandi MSci., 2000, Physics, Queen Mary and Westfield College, University of London; Ph.D., 2005, Applied Physics, Stanford University. Post-Doctoral Scholar, University of California, Berkeley, Post-Doctoral Fellow, Lawrence Berkeley National Laboratory, 2005 – 2008. Assistant Professor of Materials Science and Engineering, 2008; Associate Professor, 2014. Scientific Founder, KitoTech Medical. CAREER Award National Science Foundation, 2012. Resigned to take position at the University of California, Santa Cruz, 2015.

Eleftheria Roumeli, Bachelor in Physics, 2009, Aristotle University of Thessaloniki (Greece); M.Sc., 2011, Materials Physics & Technology, Aristotle University of Thessaloniki; PhD, 2014, Physics, Aristotle University of Thessaloniki. Postdoctoral Researcher: Department of Materials Science & Engineering, University of Ioannina (Greece) 2014-2015; Postdoctoral Research Fellow in the Department of Physics Tampere University of Technology (Finland) 2015; post-doctoral in the Department of Mechanical & Process Engineering ETH Zürich (Switzerland) 2015-2017; post-doctoral in the Department of Mechanical & Civil Engineering California Institute of Technology 2017-2019. Joining MSE faculty in 2019-2020.

Mehmet Sarikaya B.S., 1976, Metallurgical Engineering, Middle East Technical University; M.S., 1979, Ph.D., 1982, Materials Science and Engineering, University of California at Berkeley. Assistant Professor of Materials Science and Engineering at U.W., 1984; Associate Professor in 1989. Currently on the faculty.

William D. Scott B.S., 1954, Ceramic Engineering, University of Illinois; M.S., 1959, Ceramic Engineering, Ph.D., 1961, Engineering Science, University of California at Berkeley. Research Assistant Professor and Acting Assistant Professor of Mineral Engineering at U.W., 1965; Assistant Professor of Ceramic Engineering, 1968; Associate Professor, 1970; Full Professor, 1976; Elected Fellow of the American Ceramic Society in 1977. Retired as Professor Emeritus in 1998.

Robert G. Stang B.S., 1961, Long Beach State College; M.S., 1965, University of California at Los Angeles; Ph.D., 1972, Stanford University. Assistant Professor of Mining, Metallurgical, and Ceramic Engineering at U.W., 1973; Associate Professor, 1979. Retired in 2001.

Thomas G. Stoebe B.S., 1961; M.S. Materials Science, 1963; Ph.D. Materials Science, 1965, Stanford University. Assistant Professor of Metallurgical Engineering at U.W., 1966; Associate Professor in 1969; Professor in 1975; Director of High School Relations for the College of Engineering, 1977; Associate Dean for Development and College Relations in the College of Engineering, 1982; Associate Dean for Research, 1984; Professor and Acting Chairman of

Materials Science and Engineering, Associate Dean in the College of Engineering, and Adjunct Professor of Nuclear Engineering, 1986; Chairman of the Department of Materials Science and Engineering, 1987-1996. Elected Fellow of ASM International in 1992. Retired as Professor Emeritus in 2001 and continues as a consultant on materials education.

Christopher Viney B.A., 1980; M.A., 1984, Ph.D., 1983, Metallurgy and Materials Science, Trinity College, Cambridge University. Assistant Professor of Materials Science at U.W., 1987; transferred to primary appointment in Bioengineering and appointed Affiliate Professor of MSE,1990; Associate Professor, 1993. Resigned from the UW in 1995. Currently Professor at UC-Merced.

Osgood J. Whittemore, Jr. B.S., Ceramic Engineering, 1940, Iowa State University; M.S. Ceramic Engineering, 1941, University of Washington; Prof., Ceramic Engineering, 1950, Iowa State University. Associate Professor of Mineral Engineering at U.W., 1964; Professor of Ceramic Engineering, 1969; elected Fellow of the American Ceramic Society in 1960; Director of the Washington Mining and Mineral Resources Research Institute, 1982. Retired in 1987 as Professor Emeritus. He passed away in 2010.

Hewitt Wilson B.S., Ceramic Engineering, Ohio State University, 1913. Assistant Professor of Ceramic Engineering at U.W., 1918; honorary degree of Doctor of Science, Montana School of Mines, 1937. Left in 1938 to join USBM in Tennessee. The U.W. Kiln Building was renamed for him in 1955 as the Hewitt Wilson Ceramic Laboratory. He passed away in 1953.

Xiaodong Xu B.A., 2002, Physics, University of Science & Technology of China; Ph.D., 2008, Physics, University of Michigan. Postdoctoral Fellow, Department of Physics, Cornell University, 2009-2010. Assistant Professor, Physics & Materials Science and Engineering, University of Washington, 2010; Associate Professor, 2015; Professor, 2018. AAAFM-Heeger Award, 2019 Web of Science, Cottrell Scholar Award 2014, DoE Early Career Award 2012, NSF Early Career Award 2012, DARPA Young Faculty Award 2011. Currently on faculty.

Jihui Yang B.S., 1989, Physics, Fudan University; M.S., 1991, Physics, University of Oregon; M.S., 1994, Radiological Physics, Wayne State University; Ph.D., 2000, Physics, University of Michigan. Lab Group Manager & Technical Fellow, Electrochemistry and Battery System Group, Electrochemical Energy Research Lab, General Motors Research and Development Center, 1996-2011. Kyocera Associate Professor of Materials Science and Engineering, University of Washington, 2011; Kyocera Professor, 2017. Department Chair, Materials Science and Engineering, University of Washington, 2017-present. Currently on faculty.

Matthew Yankowitz B.S., 2011, Physics, Stanford University; Ph.D., 2015, Physics, University of Arizona. Postdoctoral Research Scientist, 2016 – 2018, Physics, Columbia University. Assistant Professor of Physics and Materials Science and Engineering, 2019- present. Currently on faculty.

Miqin Zhang B.S., 1983, Metallurgical/Chemical Engineering, Jiangxi University of Science and Technology, China; M.S., 1993, Mechanical Engineering, University of Victoria, Canada; Ph.D., 1999, Materials Science and Engineering, UC Berkeley. Assistant Professor, Department of

Materials Science and Engineering, University of Washington, 1999**;** Associate Professor 2005; Professor 2008. Kyocera Professor of Materials Science and Engineering, 2011-present. Most highly cited researcher by multiple materials science and engineering societies and organizations. Currently on faculty.

Navid Zobeiry, 2001 B.Sc., Civil Engineering, University of Tehran, Iran; M.A.Sc., 2004, Structural Engineering, University of British Columbia, Canada; Ph.D., 2010, Structural Engineering, University of British Columbia, Canada. Postdoctoral Research Fellow, Civil Engineering Department, University of British Columbia, Canada, 2010-2012. Research Associate and Sessional Lecturer, Materials Engineering Department, University of British Columbia, 2012 – 2018. Currently on faculty.

Richard R. Zupp B.S., 1962; M.S., 1963; Ph.D., 1966, Stanford University. Assistant Professor at U.W., 1968. Left in 1972 to enroll in a medical program at the University of Miami. Practiced medicine in Fresno, CA.

Carl H. Zwermann, Director of Ceramic Engineering at U.W., 1938-41. Left the University to serve in the military; returned in 1947, remaining until 1949. Passed away in 1990.

Appendix II

1.	Henry Landes	1895 - 1936	
2.	Dorsey A. Lyon	1898 – 1901	
3.	Milnor Roberts	1901 – 1947	
4.	Clarence R. Corey	1907 – 1947	
5.	Joseph Daniels	1911 - 1954	
6.	Hewitt Wilson	1918 – 1938	
7.	Carl H. Zwermann	1938 – 1949	
8.	Joseph A. Pask	1941 – 1943	
9.	Drury A. Pifer	1945 – 1970	
10.	Donald L. Anderson	1947 - 1982	
11.	James I. Mueller	1949 – 1986	
12.	Edward E. Mueller	1953 - 1959	
13.	Frederick B. Brien	1954 – 1975	
14.	Earl C. Roberts	1954 – 1972	
15.	Robert J. Campbell, Jr.	1955 - 1982	
16.	Douglas H. Polonis	1955 – 1996	
17.	Alan D. Miller	1957 – 1996	
18.	William F. Flanagan	1959 - 1966	
19.	Thomas F. Archbold	1961 - 1997	
20.	Barry D. Lichter	1964 – 1968	
21.	Osgood J. Whittemore, Jr.	1964 - 1987	
22.	William D. Scott	1965 - 1998	
23.	Henk I. Dawson	1966 - 1973	
24.	Thomas G. Stoebe	1966 - 2001	
25.	Richard R. Zupp	1968 - 1972	
26.	David B. Fischbach	1969 – 1992	
27.	John H. Jones	1969 - 1976	
28.	Robert G. Stang	1973 - 2001	
29.	David C. Lynch	1976 - 1984	
30.	Y . Krishna Rao	1980 – 2012	
31.	Ilhan A. Aksay	1983 - 1992	
32.	Richard C. Bradt	1983 - 1989	
33.	Ryoichi Kikuchi	1984 - 1987	
34.	Mehmet Sarikaya	1984 - present	
35.	Michael J. Kaufman	1986 - 1988	
36.	Christopher Viney	1987 - 1995	
37.	Thomas P. Pearsall	1989 – 2001	
38.	Lucien Brush	1990 – present	
39.	Gretchen Kalonji	1990 – 2005	
40.	Rajendra Bordia	1991 – 2013	
41.	Fumio Ohuchi	1992 – present	
42.	Sossina Haile	1993 – 1996	
43.	Brian Flinn	1995 – 2016	
44.	Guozhong Cao	1996 – present	
45.	Alex Jen	1999 – 2016	
46.	Miqin Zhang	2000 – present	
47.	Kannan Krishnan	2001 – present	
48.	Christine Luscombe	2006 – present	
49.	Marco Rolandi	2008 – 2015	
50.	Xiaodong Xu	2010 – present	
51.	Peter Pauzauskie	2010 – present	
52.	Jihui Yang	2011 – present	
53.	Dwayne Arola	2013 – present	
54.	Bruce Hinds	2014 – present	
55.	J. Devin MacKenzie	2015 – present	
56.	Jun Liu	2018 – present	
57.	Ting Cao	2018 – present	
58.	Navid Zobeiry	2019 – present	
59.	Matthew Yankowitz	2019 – present	
60.	Eleftheria Roumeli	2019 – present	
61.	Arthur Barnard	2020	